

Santa Isabel Municipality
Solid Waste Landfill
Administrative Order on Consent
Docket No. RCRA-02-2011-7303

Compliance with Requirement Memo
ID No. 52-A

Revised Closure and Post Closure Plans.

**Revised Closure Plan
for the Santa Isabel
Municipal Solid Waste Landfill**

Prepared By



Municipality of Santa Isabel

Prepared For

United States Environmental Protection Agency

**Administrative Order on Consent
Docket No. RCRA-02-2011-7303**

June, 2012 - Rev. January 2014



ESTADO LIBRE ASOCIADO DE PUERTO RICO
MUNICIPIO AUTÓNOMO DE SANTA ISABEL
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February 12, 2014

Meghan La Reau
Project Coordinator
U.S. Environmental Protection Agency, Region 2
RCRA Compliance Branch, 21st Floor
290 Broadway
New York, New York 10007-1866

RE: Revised Closure and Post Closure Plans.
Compliance with Requirement Memo. Id No. 52-A.
Administrative Order on Consent
Municipality of Santa Isabel
Docket No.: RCRA-02-2011-7303

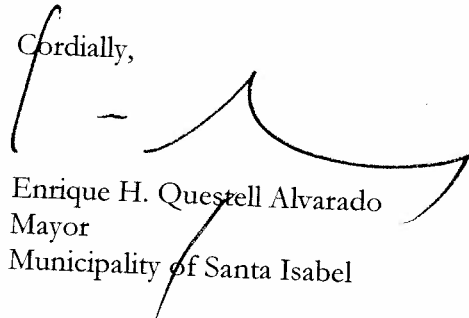
Dear Mrs. La Reau:

The Municipality of Santa Isabel is glad to submit to the U.S. Environmental Protection Agency, Region 2 the "Revised Closure and Post Closure Plans (Revision 2, January 2014)" for the city landfill. This Document corresponds to requirement 52 of the Administrative Order on Consent, Santa Isabel Municipal Landfill, Docket Number RCRA-02-2011-7303. We consider compliance with requirements 52a, 52b, 53c, 52d and 52e to be subsidiary to this memo.

Please, refer to "Compliance with Requirement Memo", Id No. 52-A, here included.

If you have further questions about this matter, please feel free to contact us.

Cordially,


Enrique H. Questell Alvarado
Mayor
Municipality of Santa Isabel

SANTA ISABEL MUNICIPALITY
SOLID WASTE LANDFILL
ADMINISTRATIVE ORDER ON CONSENT
DOCKET NO. RCRA-02-2011-7303

COMPLIANCE WITH REQUIREMENT MEMO
ID NO. 52-A

DATE: February 12, 2014

REQUIRMENTS NO. 52.

DESCRIPTION: Revised Closure and Post Closure Plan.

ACTION TAKEN:

- A Revised Closure and Post-Closure Plan was submitted to EPA on June 2012.
 - On September 25, 2012, EPA conditionally accepted the Plan pending the submittal, acceptance, and subsequent incorporation of design plans and specifications for fencing and a gate at the north storm water channel opening.
 - Landfill Closure project, as originally scheduled, got delayed due to the Municipality budget constraints and many other related issues. The Municipality retained the services of the designer on December, 2013 to complete the 2nd revision of the Closure and Post-Closure Plan for the Landfill.
 - The Revised (2nd revision) Closure Plan had been completed and is included with this memo.
-

ATACHMENTS:

1. Revised Closure and Post-Closure Plan for the Santa Isabel Solid Waste Landfill. (2nd Revision, January, 2014)
-

ACTION REQUIRED:

1. The project proposed schedule will have to be discussed in further detail with USEPA in order to properly plan the require closure and post closure activities taking in consideration the Municipality financial planning for the project.
2. EPA needs to review the Revised Closure and Post-Closure Plans for acceptance or non-acceptance.

ATTACHMENT 1

**Revised Closure Plan
for the Santa Isabel
Municipal Solid Waste Landfill**

**Prepared By
Landfill Gas Technologies Corp.
Gurabo, Puerto Rico**

Municipality of Santa Isabel

**Prepared For
United States Environmental Protection Agency
Administrative Order on Consent
Docket No. RCRA-02-2011-7303
June, 2012 - Rev. January 2014**

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**REVISED CLOSURE PLAN
FOR THE SANTA ISABEL
MUNICIPAL SOLID WASTE LANDFILL
JUNE 2012 – REVISED JANUARY 2014**

1. Background and Introduction

The Santa Isabel Municipal Solid Waste Landfill (MSWLF) (referred to herein as “Site”), located in Santa Isabel Puerto Rico, is subject to an Administrative Order on Consent (Docket No. RCRA-02-2011-7303 referred to herein as the “Consent Order”) by the United States Environmental Protection Agency (USEPA). **Appendix A** provides a copy of the Consent Order.

The Facility, located at Km. 4.0, PR-543, Municipality of Santa Isabel, Puerto Rico, is a “municipal solid waste landfill unit,” as that term is defined at 40 C.F.R. § 258.2. As an existing municipal solid waste landfill; the Facility is subject to many of the requirements set forth in 40 C.F.R. Part 258. The landfill is also subject to the Non-Hazardous Solid Waste Management Regulations of Puerto Rico, administered by the Puerto Rico Environmental Quality Board (“PREQB”).

Respondent has been the “owner” at the Landfill since at least 1979, as that term is defined in 40 C.F.R. § 258.2 and has contributed and continues to contribute to the handling and disposal of solid waste at the landfill in its capacity as owner. Respondent Municipality has been the “operator” of the Landfill at various times during its ownership of the Landfill including from September 2, 2005 to May 1, 2006 and from October 1, 2006 to the present. During these times, it contributed and/or continues to contribute to the handling and disposal of solid waste at the Landfill in its capacity as an operator.

In 1993, PREQB ordered the Landfill to stop receiving waste. In 1999, the PREQB alleged in an Administrative Order that the Landfill received solid waste in 1999 without proper authorization or approval. In 2003, based on a PREQB Resolution, the Landfill reopened and began accepting municipal solid waste.

According to a study prepared for the Puerto Rico Solid Waste Management Authority, the Landfill was receiving approximately 350 cubic yards per day of municipal solid waste in March 2006. This waste consisted primarily of household waste which includes, among other things, plastics, papers, garbage, and household hazardous waste.

Authorized representatives of USEPA inspected this Landfill on or about November 17, 2005, March 24, 2006, August 6, 2009, March 24, 2010, March 31, 2011, and April, 2011. During those inspections, USEPA obtained information concerning the Landfill and its waste disposal practices, determining a lot of findings and the lack of adequate environmental controls.

On August 30, 2007, Respondent (and two former operators of the Landfill) jointly entered into an Administrative Order on Consent with USEPA, Docket No.: RCRA-02-2007-7302, ("2007 AOC") in which the Municipality and two former operators agreed to close the Landfill pursuant to the requirements specified therein. Respondent represented to EPA that financial constraints prevented it from closing the Landfill pursuant to the timeframes set forth in the 2007 AOC. The Municipality of Santa Isabel asked USEPA to enter into a new

Administrative Order on Consent providing for a revised schedule for a delayed phased closure of the Landfill with the Municipality as the sole Respondent signing the Order. The parties agreed that any new Administrative Order on Consent should contain a recycling program as a means to reduce amount of waste disposed of in the Landfill during its remaining life.

The Regional Administrator of USEPA Region 2, upon receipt of evidence and information that the past and present handling and disposal of solid wastes at the Landfill may present an imminent and substantial endangerment to human health and the environment, determined that the issuance of a new order was necessary to protect public health and the environment. The Respondent shall perform the actions required by the Order and comply with its provisions.

One of the requirements included in the Order is that a professional engineer or engineers licensed by the Commonwealth of Puerto Rico shall revise Respondents November 2008 Closure Plan Report, as well as develop a plan setting forth all necessary measures and procedures for post-closure care of the Facility (the "Revised Closure Plan" and the "Post-Closure Plan").

The Revised Closure Plan shall, unless otherwise approved by EPA in writing, provide the phased closure of the Landfill over a three year period. By no later than December 31, 2011, respondent shall cease depositing waste in the Northern third of the Landfill and place either an intermediate cover below or a final cover on that portion of the Landfill (Phase I of Interim Closure). By no later than December 31, 2012, Respondent shall cease depositing waste in a

second area that entails approximately one third of the Landfill and place either an intermediate or final cover on that portion of the Landfill (Phase II of Interim Closure). By no later than September 30, 2013, Respondent shall cease receiving any waste for deposit in the Landfill (unless approved by USEPA in writing) and depositing waste in the final third of the Landfill. Respondent shall permanently close the entire Landfill (Final Closure) pursuant to the Revised Closure Plan by December 31, 2013.

Post-closure care must begin, and financial assurance must be obtained, upon the completion of Final Closure on December 31, 2013. Post closure shall be performed pursuant to the terms and time schedules set forth in the approved Post-Closure Plan.

A Revised Closure and Post-Closure Plans, was necessary to be submitted to USEPA for review and approval, in which all necessary engineering reports and associated plans and specifications to meet the requirements set forth above were incorporated.

The revised Closure plan was respectfully submitted to the USEPA and the PREQB in compliance with Administrative Order on Consent Docket No.: RCRA-02-2011-7303 on June 2012. This Plan provided for the closure design of the Site (approximately 15 acres in size).

The purpose of the referred Closure Design Plan was to present a current status and the proposed permit-level design of the closure cap and related

appurtenances for the existing site. This closure plan included an engineering report, permit-level drawings (included as **Appendix B**), and supporting calculations to close the Landfill in accordance with RCRA Subtitle D regulations. The design presented in the above mentioned report was for permitting purposes only and shall not be used for construction.

The June 2012 plan was commented by USEPA on August 2012 and a revised Plan incorporating these comments was prepared immediately.

Notwithstanding, a new Revised Closure Plan has been prepared to present a current status (2014) of the Santa Isabel Municipal Solid Waste Landfill taking in consideration the followings:

- Comments from USEPA.
- The different activities that have been implemented by the Municipality of Santa Isabel within the landfill during the last months.
- New topographic plan of the landfill prepared recently by the Municipality at the end of 2013.
- Existing financial constraints of the Municipality to implement the closing of the landfill as required in the Administrative Order of Consent.

Notwithstanding, the design presented in this new revised Closure plan is for permitting and construction purposes.

2. General Site – Facility Description

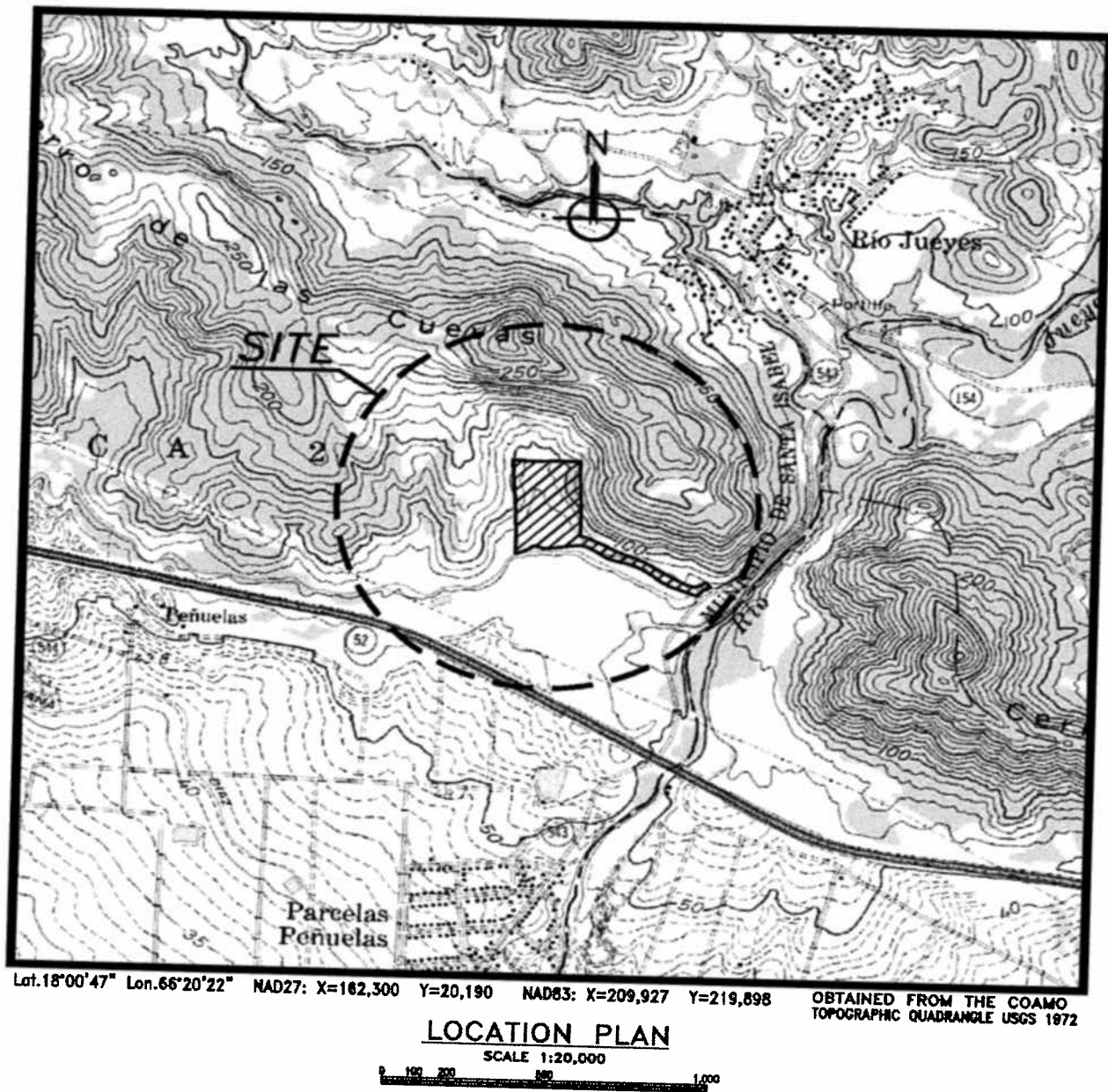
2.1 Location and General Adjacent Land Use

The MSWLF is located in the Jauca 2 Ward on the Municipality of Santa Isabel at Road 543, Km. 4.0, just North of Highway 52 (refer to figures 1 and 2). A location map is also included in the drawing set included as **Appendix B** of this report. The landfill property is mostly surrounded by undeveloped land. The Landfill is located north of an intermittent tributary of the Jueyes River and next to a pasture where cattle graze.

2.2 Geotechnical Conditions and Soil Types

Based on general data included on the Consent Order “the Landfill is located over an alluvial unconfined (water-table) aquifer within the South Coast Aquifer System”. “Regional groundwater movement is southward toward the coast with some possible lateral movement toward major streams.

A detailed description of the geotechnical conditions in the area of the landfill and the soil types within the area of the landfill shall be prepared prior to any construction activities. This study shall be performed by a geotechnical engineer licensed by the Commonwealth of Puerto Rico. All closure drawings shall be reviewed by the geotechnical engineer.



SANTA ISABEL MUNICIPAL SOLID WASTE LANDFILL

FIGURE 1



AERIAL PHOTO

SANTA ISABEL MUNICIPAL SOLID WASTE LANDFILL

FIGURE 2

2.3 Facility Background

According to the available information solid waste disposal activities began at the landfill site in the late seventies (1970's).

The information gathered also indicates that the solid waste disposal of at the facility was collected primarily from residences, commercial establishments, governmental, buildings and agricultural and industrial

facilities located within the Municipality of Santa Isabel. According to the Solid Waste Characterization Study (Wehran, 2003), the Santa Isabel Landfill accepts only waste from the municipality of Santa Isabel, which consists primarily of municipal solid waste, construction debris, yard waste, and auto waste. The average waste generated by the Municipality was estimated to be 697 tons of waste per week (Wehran, 2003).

As mentioned before closure activities began on the site several years ago when the landfill facility was ordered to stop receiving waste by the PREQB. In 2003, based on a PREQB Resolution, the landfill reopened and began accepting municipal solid waste.

2.4 Status of Current Landfill Closure Operation

As required by the AOC, the deposit of waste in the landfill ceased since September 30, 2013. Also, an intermediate cover on the northern third portion of the Landfill was placed complying with Phase I of Interim Closure as identified in the Consent Order. In addition all the remaining areas of the landfill have been covered appropriately.

2.5 Cessation of Waste Acceptance

Based on the information included in the Consent Order the landfill facility cease receiving any waste for deposit on September 30, 2013. This goal was achieved as mentioned before.

2.6 Property Ownership

Based on information provided by the Municipality of Santa Isabel, the municipality owns the landfill site.

2.7 Closure Area

Based on the available information gathered from the survey and existing site condition plans, the total closure project area is estimated at 15.6871 “cuerdas” (15.2356 acres). No land acquisition is contemplated for the rehabilitation and closure of this landfill.

2.8 Facility Operation

LM Waste Service Corp. was the landfill operator from October 22, 2003 until September 1, 2005. VA Waste Management Corp. was the operator from May 1, 2006 to September 30, 2006. Then, the Municipality of Santa Isabel worked at the facility as the operator until the cessation of waste acceptance. The facility is currently maintained by the Municipality.

3. Closure Design Consideration

Various environmental impacts of landfills occur long after the landfill has closed. These impacts can be mitigated by good design and operation of the landfill, best practice rehabilitation and long-term post closure care of the site. Best management practices are essential in the rehabilitation and closing of the Santa Isabel Municipal Landfill. A portion of this landfill needs to be rehabilitated and prepared for closing. In order to ensure that the objectives of rehabilitation are achieved, a conceptual rehabilitation plan shall be developed as part of the landfill closure plan. The rehabilitation plan shall deal with operation guidelines, future use options and provide a blueprint for the final surface contours and cap design of the whole landfill area.

In summary, current regulations require owners/operators of all Municipal Solid Waste Landfill (MSWLF) units to install, at closure, a final cover system designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} centimeters per second, whichever is less;
- Minimize infiltration through the closed MSWLF using an infiltration layer that contains a minimum of 18 inches of earthen material; and
- Minimize erosion of the final cover using an erosion layer that contains a minimum of 6 inches of earthen material capable of sustaining native plant growth.

The owners/operators of all MSWLFs also must prepare written closure plans that describe the steps necessary to close all MSWLF units at any point during their active life. After the closure of each MSWLF unit, the owner/operator must conduct post-closure care for at least 30 years, or as otherwise required by the government agencies, and at a minimum:

- Maintain the integrity and effectiveness of any final cover;
- Maintain and operate the leachate collection system in accordance with the requirements specified in current regulations;
- Monitor the ground water in accordance with the current requirements and maintain the ground-water monitoring system; and
- Maintain and operate the gas monitoring system if present, in accordance with the current requirements.

Note that current regulations provide little guidance on the design of final covers and specific elements that might be required in the cover. This closure plan reviews design considerations for both the Subtitle D design objectives and for objectives not directly addressed by Subtitle D. Design considerations discussed include those for the required infiltration and erosion control layer. Also discussed are supplementary layers, which commonly are used in final covers. The supplementary layers reviewed in this report include a drainage used to maintain the stability of the erosion control layer on side slopes and the gas venting system used to reduce the buildup of gas pressure within the MSWLF.

The design components and considerations for Municipality of Santa Isabel MSWLF closure will include among others:

- Profile of the cover;
- Infiltration (barrier) layer or an alternative barrier system;
- Drainage layer;
- Erosion control layer;
- Gas venting system;
- Landfill cover slope stability;
- Subsidence effects;
- Weather effects; and
- Documentation of closure.

These components and considerations are discussed later in this document. The following general information has also been included in this document:

- A general description of the Landfill including historical information;
- A general description of the final cover to be constructed for the Landfill and the stormwater management system;
- A general description of the Landfill closure procedures;
- A general description of the system, which will be used to monitor, after closure, the environmental impacts of the Landfill; and
- A general description of the procedures, which will be used to maintain the Landfill after closure.

An integral part of this revised Plan are the design drawings for the closure of the whole sanitary landfill that are included as part of **Appendix B**. All design closure drawings and specifications have been signed and sealed by a licensed professional engineer properly registered in the Commonwealth of Puerto Rico.

The design drawings provide information regarding the proposed construction of the final cover and the storm water management system structures for the closure, as well as all other closure related components, taking in consideration the phases required by the Consent Order and the applicable regulations.

3.1 Existing Conditions Topographical Survey

Currently, the Municipality of Santa Isabel (the owner) has performed new field survey activities for the preparation of an updated topography survey (see figure 3, Existing Condition Plan).

3.2 Regulations Summary

The following sections provide a general guideline of the closure project design parameters and/or concept as required by the applicable regulations. It shall be noted that agencies with jurisdiction over the closure activities of the MSWLF (i.e. USEPA and PREQB) may authorize or require additional activities for the proper closure of the MSWLF.

3.2.1 Infiltration (Barrier) Layer

The infiltration (barrier) layer for MSWLFs having only a soil liner consists of a compacted soil layer with a minimum thickness of 18 inches and a maximum permeability of 1×10^{-5} centimeters per second (cm/s). For MSWLF that use a composite liner system, a geomembrane must be added above the compacted soil layer. Both infiltration layer systems shall be designed to reduce the rate at which surface waters infiltrate the MSWLF to below the rate at which leachate moves through the liner system.

An alternative barrier system with infiltration equivalent to or less than the system described in the regulations may be used if approved by the USEPA and the PREQB. The geomembrane material used for the final cover must be long-lasting and must tolerate anticipated subsidence induced strains. As an alternative to HDPE, polymers with more suitable biaxial stress-strain capacity should be considered. Typical biaxial stress-strain curves for HDPE and alternative geomembrane polymers shall be used for design purposes. Materials with high biaxial strength more easily withstand the differential settling that can occur after closure, thereby resisting failure.

Based on a preliminary review of the site conditions, the Santa Isabel MSWLF closure is proposed to be built using clay material.

3.2.2 Erosion Control Layer

The minimum thickness of erosion layer required by current regulations is 6 inches. Soil loss (erosion) caused by rainfall can be calculated by the universal soil loss equation:

$$X = RKSLCP$$

Where:

X = Soil loss

R = Rainfall erosion index

K = Soil erodability factor

S = Slope gradient factor

L = Slope length factor

C = Crop management factor

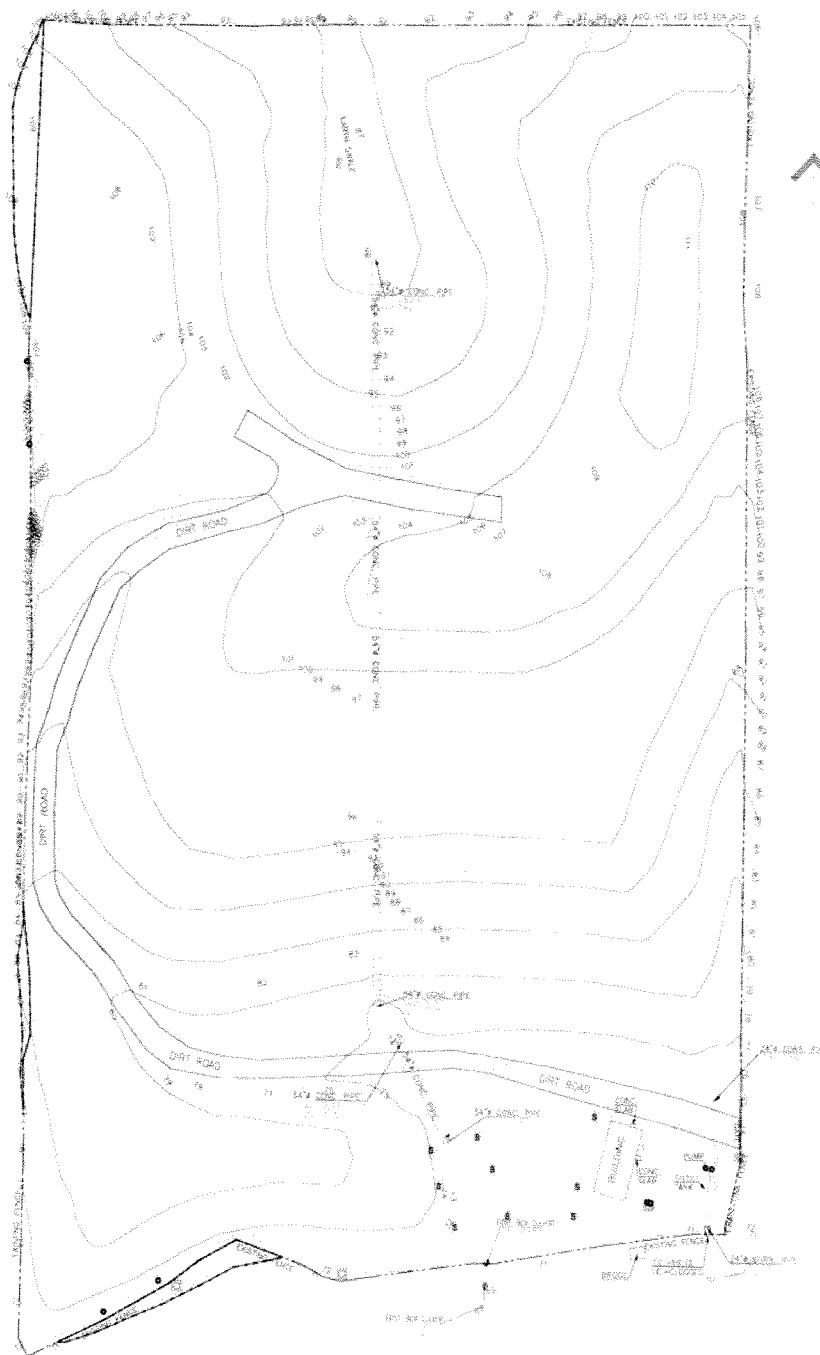
P = Erosion control practice

These parameters can be evaluated using data available in soil erosion textbooks and EPA technical resource documents. Erosion-related soil loss should not exceed 2 tons per acre per year to minimize long-term maintenance.

Meeting this level of erosion control typically requires the uses of slopes equal or less than 3H : 1V and drainage swales and sediment prevention controls placed at approximately 30 foot vertical increments.

Water-related erosion can be controlled not only by vegetation, but also by hardening cover surface using stones or riprap. Such hardened covers allow more water to infiltrate than vegetative covers because no vegetative evapotranspiration occur. Hardened covers increase the need for a barrier layer but reduce long-term maintenance. The Santa Isabel MSWLF closure erosion control layer shall include several design parameters such as but not limited to compacted clay layers, top soil with vegetation, storm-water management downchutes, storm-water management channels, erosion control mats among others.

The details of the design materials have been included on the closure design drawings (see **Appendix B**).



EXISTING CONDITIONS PLAN (JANUARY 2014)
(FOR MORE DETAILS SEE APPENDIX B)
SANTA ISABEL MUNICIPAL SOLID WASTE LANDFILL
FIGURE 3

3.2.3 Methane Gas Management / Collection System

The Administrator for the U.S. Environmental Protection Agency (USEPA) has determined that municipal solid waste landfill gases such as non-methane organic compounds (NMOC), carbon monoxide and methane contribute significantly to air pollution. Pursuant to section 111 of the Clean Air Act (CAA), the USEPA promulgated New Source Performance Standards (NSPS) for “new” municipal solid waste (MSW) landfills and Emission Guidelines (EG) for “existing” MSW landfills to control the emission of landfill gases.

The final rule and guidelines, effective on March 12, 1996 also added “MSW landfills” as a source category to the priority list of sources in 40 CFR § 60.16 for regulation under section 111 of the CAA. The NSPS and EG requirements, adopted under section 111 of the CAA, apply to any new MSW landfill with a maximum design capacity equal to or greater than 2.5 million megagrams (Mg) or 2.5 million cubic meters (m³). For NSPS purposes, a landfill is considered “new” if the facility started construction, reconstruction, modification or began initial acceptance of waste on or after May 30, 1991.

Emission guidelines, promulgated under Section 111 (d) of the CAA establish criteria for the control of landfill gases from “existing” MSW landfills using “best demonstrated technology”. A MSW landfill will be considered an existing or “designated” MSW landfill under either of the following conditions: (1) the landfill owner/operator began construction,

86. Nothing in this Order shall be construed to limit or otherwise affect EPA's right of access and entry pursuant to any applicable laws and regulations.

87. Nothing in this Order shall be construed to limit or otherwise affect Respondent's liabilities and obligations to perform corrective action, including corrective action beyond the Landfill property boundary, notwithstanding the lack of access. EPA may determine that additional on-site measures must be taken to address releases beyond the Landfill Facility boundary if access to off-site areas cannot be obtained.

XXI. NO FINAL AGENCY ACTION

88. Notwithstanding any other provision of this Order, no action or decision by EPA pursuant to this Order, including without limitation, decisions of the Regional Administrator, Region 2, or any authorized representative of EPA, shall constitute final agency action giving rise to any rights of judicial review prior to EPA's initiation of a judicial action for a violation of this Order, which may include an action for penalties, an action to compel one or more Respondents' compliance with the terms and conditions of this Order, or such other relief as may be available at law.

89. In any action brought by EPA for a violation of this Order, Respondent shall bear the burden of proving that EPA's action was arbitrary and/or capricious and not in accordance with law, or this Order. In any such action, EPA shall bear the burden of proving that Respondent has violated a term or terms of this Order.

XXII. MODIFICATION

90. This Order may be amended by Respondent and EPA. Such amendment(s) shall be in writing, shall first be signed by Respondent, and shall have as their effective date the date on which they are signed by the EPA Regional Administrator.

91. Notwithstanding the above, EPA's and the Respondent's Project Coordinators may agree to changes in the scheduling of events. Any such changes shall normally be requested in writing by the Respondent and must be approved in writing by the EPA PC.

92. No informal advice, guidance, suggestions, or comments by EPA regarding reports, plans, specifications, schedules, and any other writing submitted by the Respondent will be construed as an amendment or modification to this Order.

XXIII. TRANSFER OF OBLIGATIONS

93. Respondent shall give notice, and a copy, of this Order to any successor in interest prior to any transfer of ownership or responsibility for the Landfill Facility. Respondent shall give notice to EPA at least sixty (60) days prior to any such transfer. No such transfer shall in any way alter, extinguish or otherwise affect Respondent's responsibility to meet all the terms and

obligations of this Order. Respondent may, however, transfer the responsibility for unperformed obligations imposed by this Order to a new owner/operator of the Landfill Facility, provided there is a demonstration provided to EPA's satisfaction that the new owner/operator is capable of undertaking these obligations and has expressly agreed to do so in writing, provided further that EPA has given its approval in writing to any such transfer of obligations, and provided finally that this Order has been modified to reflect the transfer. Any stipulated penalties which may have accrued pursuant to the terms of this Order shall remain the responsibility of the Respondent against whom the penalties accrued unless EPA consents in writing to the transfer of said liability to the successor. The Order Modification reflecting the transfer of obligations to a successor party or parties may, if appropriate, establish modified schedules for continuing obligations under the Order.

XXIV. DISPUTE RESOLUTION

94. All parties shall use their best efforts to informally and in good faith resolve all disputes and differences of opinion, which may arise concerning provisions of this Order. Notwithstanding the above, if Respondent disagrees, in whole or in part, with any disapproval or modification or other decision or directive made by EPA pursuant to this Order, Respondent shall notify EPA in writing of its objections and the basis (bases) therefore within twenty (20) days of receipt of EPA's disapproval, modification, decision, or directive. Said notice shall set forth the specific points of the dispute, the position Respondent maintains, the basis (bases) for Respondent's position, and any matters the Respondent considers necessary for EPA's determination. EPA may unilaterally refuse to review disputes brought by Respondent under this provision if Respondent fails to fully set forth the basis (bases) of its position and/or fails to provide material(s) which are necessary for EPA's determination. EPA may, but is not obliged, to ask Respondent for additional information regarding the points of dispute raised by Respondent. To the extent additional information is requested from Respondent by EPA, this information must be submitted in full pursuant to the schedule set by EPA. EPA may refuse to consider the dispute if this information is not timely provided. To the extent, EPA refuses to review the dispute, EPA's original determination (leading to the dispute) remains in effect and shall be binding.
95. Notwithstanding the above, Respondent may not invoke the dispute resolution procedures for any deadline or compliance requirement already agreed to by the parties and set forth in the AOC. EPA's and the Respondent's Project Coordinators may agree to changes in the scheduling of events pursuant to the provisions set forth in Section XXII. Modification of this AOC.
96. Within thirty (30) days of EPA's receipt of such written notice (including any additional information requested by EPA in its discretion pursuant to Paragraph 94 above), or by such other date as established by EPA. EPA shall provide Respondent with a written determination by the Director of the Division of Enforcement and Compliance Assistance, Region 2, EPA or her representative indicating EPA's decision on the pending dispute, including any refusal to review the dispute based on insufficient information. This determination shall be binding.

97. EPA's determination shall be incorporated into and become an enforceable part of this AOC and shall no longer be subject to dispute pursuant to this AOC. Respondent shall proceed in accordance with the Director's or her representative's determination regarding the matter in dispute, regardless of whether Respondent agrees with the determination. If Respondent does not agree to perform or does not actually perform the Work in accordance with EPA's decision, EPA reserves the right in its sole discretion to conduct the Work itself, seek reimbursement from Respondent, seek enforcement of this AOC, seek stipulated penalties, and/or seek any other appropriate relief. Any disputes arising under this AOC are not subject to judicial review until such time as EPA seeks to enforce this AOC.

98. The parties may continue to confer and to use informal efforts to resolve the dispute during the period that EPA's final determination is pending. If EPA and Respondent reach agreement on the dispute at any stage, the agreement shall be set forth in writing and shall, upon signature of both parties, be incorporated into and become an enforceable part of this AOC.

99. The existence of a dispute and EPA's consideration of matters placed in dispute shall not excuse, toll, or suspend any compliance obligation or deadline required pursuant to this AOC during the pendency of the dispute resolution process except as agreed by EPA in writing. Stipulated penalties shall continue to accrue but need not be paid on obligations subject to dispute during the dispute resolution period provided Respondent has met its obligations under this Section. If Respondent does not prevail upon resolution, all penalties shall be due to EPA within 30 days of resolution of the dispute. If Respondent prevails upon resolution, no penalties shall be paid. In the event that Respondent prevails in part, penalties shall be due on those matters in which Respondent did not prevail.

XXV. TERMINATION

100. This Order and all of its terms and provisions shall remain in effect until all of the activities called for by the Order are completed and Respondent is so notified in writing by the EPA. Such notice shall be signed by the Regional Administrator, EPA Region 2. Respondent may request that EPA Region 2 provide Respondent with such notice, and shall supply EPA with such information, including certifications, as EPA may specify. EPA reserves the right to unilaterally terminate this Order in its unreviewable discretion.

XXVI. ENFORCEMENT

101. The failure of Respondent to comply with any provision of this Order may be considered a violation of this Order. Such violation may give rise to an enforcement action pursuant to Section 7003(b) of the Act, 42 U.S.C. § 6973(b), as amended by the Debt Collection Improvement Act of 1996, 31 U.S.C. Section 3701 et seq.

102. Nothing herein shall preclude EPA from taking any additional enforcement actions, and/or such other actions as it may deem necessary for the abatement or prevention of an

imminent threat to public health or the environment arising from conditions at the Landfill Facility. Nor shall EPA be precluded from taking any such other enforcement actions under the Act or other laws as EPA may deem necessary based on additional information about conditions at the Facility.

XXVII. GENERAL PROVISIONS

103. Nothing in this Order constitutes a satisfaction or release from liability with respect to any conditions or claims arising as a result of past, current or future operation, ownership or use of the Landfill Facility by the Respondent, its agents, officials, successors or assigns.

104. Nothing in this Order affects any right, claim, interest, defense or cause of action of EPA with respect to the Respondent or any third parties.

XXVIII. CONSENT/AUTHORITY TO SIGN

105. Respondent consents to and agrees not to contest EPA's jurisdiction to issue this Order. In addition, whether brought in an administrative or judicial proceeding, Respondent consents to and agrees not to contest EPA's jurisdiction to enforce or compel compliance with any term of this Order. Respondent neither admits nor denies the EPA's Findings of Fact and Conclusions of Law stated herein. Respondent enters into this Order in good faith, and the execution of this Order is not intended and shall not be construed as an admission relating to any violations of any law or regulations or an assumption of liability beyond that expressly stated herein.

106. Finding this Order to be accurate and reasonable, Respondent consents to its issuance and its terms, and agrees to undertake all actions required by the terms and conditions of this Order. Respondent consents to the issuance of this Order, as an Order, pursuant to Section 7003 of RCRA, 42 U.S.C. § 6973, and explicitly waives any rights it may have to request a hearing on this matter.

107. Respondent agrees not to contest and agrees to waive any defense concerning the validity of this Order, or any particular provision contained herein.

108. Each signatory to this Order certifies that he or she is fully authorized to sign this Order without reservation

XXIX. EFFECTIVE DATE

109. The effective date of this Order shall be fifteen (15) days after the date the Order is signed by the Regional Administrator, EPA Region 2.

Administrative Order On Consent
Santa Isabel Municipal Landfill
Santa Isabel, Puerto Rico
Docket No.: RCRA-02-2011-7303

Respondent Municipality of Santa Isabel, Puerto Rico

By: 

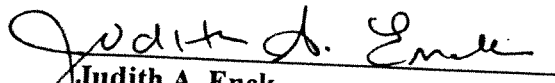
Name: Enrique Questell Alvarado
(PRINT)

Title: Mayor, Municipality of Santa Isabel

Date: August 25, 2011

Administrative Order On Consent
Santa Isabel Municipal Landfill
Santa Isabel, Puerto Rico
Docket No.: RCRA-02-2011-7303

It is so Ordered:


Judith A. Enck
Regional Administrator

Date: 9/29/11

U.S. Environmental Protection Agency, Region 2
290 Broadway
New York, New York 10007-1866

Appendix B

Revised Closure Plan

Design Drawings

REVISED CLOSURE PLAN OF SANTA ISABEL MUNICIPAL SANITARY LANDFILL

PR-543, Km. 4.1, JAUCA 2 WARD,
SANTA ISABEL, PUERTO RICO

JUNE 2012
APRIL 2013
REVISED: JANUARY 2014

PREPARED FOR:

LANDFILL GAS
RECYCLING & ENERGY

CARR. 189, KM 1.7, BO. MAMEY
CURABO, P.R. 00778
PHONE 787 273-7639 FAX. 787 687-0346

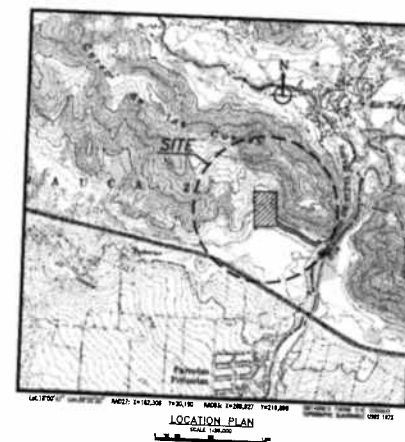


Hon. Enrique Questell Alvarado
MAYOR
MUNICIPALITY OF SANTA ISABEL

PREPARED BY:

[Signature]

Felipe Xazario & Asociados
Engineers, Planners, Environmental Consultants
Box 3871, Guaynabo, P.R. 00970
Phone: (787) 773-0730 Fax: (787) 625-3716
e-mail: www.felipenazario@yahoo.com



INDEX

SHEET No.	DRAWING No.	TITLE
1	T-1	TITLE SHEET
2	X-1	SURVEY PLAN
3	X-2(R)	GENERAL NOTES - EXISTING CONDITIONS
4	SI-1(R)	GENERAL SITE PLAN
5	SI-2	CLOSURE PHASES DELINEATION
6	SI-3(R)	FINAL GRADING AND RUN-OFF CONTROL PLAN
7	SI-4(R)	CROSS SECTIONS A-C
8	SI-5(R)	CROSS SECTIONS 1-6
9	SI-6(R)	GAS COLLECTION AND MONITORING PLAN GROUND WATER MONITORING LAYOUT
10	SI-7(R)	CLOSURE DETAILS
11	CES-1	EROSION AND SEDIMENTATION CONTROL PLAN AND DETAILS

GENERAL NOTES

1. THE INFORMATION PROVIDED IN THESE PLANS IS SOLELY TO ASSIST THE CONTRACTOR IN ASSESSING THE NATURE AND EXTENT OF THE CONDITIONS WHICH MAY BE ENCOUNTERED DURING THE COURSE OF WORK. ALL CONTRACTORS ARE DIRECTED, PRIOR TO BIDDING, TO CONDUCT WHATEVER INVESTIGATIONS THEY MAY DEEM NECESSARY, AT THEIR EXPENSE, TO ARRIVE AT THEIR OWN CONCLUSIONS REGARDING THE ACTUAL CONDITIONS THAT WILL BE ENCOUNTERED, AND UPON WHICH THEIR BIDS SHALL BE BASED.
2. FIELD CONDITIONS MAY NECESSITATE SLIGHT ALIGNMENT AND GRADE DEVIATION OF THE PROPOSED CONSTRUCTION TO AVOID OBSTACLES, AS ORDERED BY THE ENGINEER. THE CONTRACTOR SHALL CONSTRUCT THE PROPOSED FACILITIES TO THE ORDERED DEVIATION WITHOUT INCREASE IN THE CONTRACT PRICE OR TIME.
3. CONTRACTOR SHALL CERTIFY IN WRITING TO THE ENGINEER PRIOR TO STARTING WORK THE ACCURACY OF ALL SURVEY AND OTHER GRADING DATA CONTAINED IN THE CONTRACT DOCUMENTS.
4. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN BASED ON THE INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. THERE MAY BE OTHER IMPROVEMENTS, UTILITIES, ETC. WHICH ARE WITHIN THE PROJECT AREA. THE CONTRACTOR SHALL VERIFY, PRIOR TO CONSTRUCTION, THE LOCATIONS, ELEVATIONS, AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES (WHETHER OR NOT SHOWN ON THE PLANS) AFFECTING THE WORK.
5. DURING CONSTRUCTION, CONTRACTOR SHALL REPAIR OR REPLACE MONITORING WELLS/PIEZOMETERS DAMAGED DURING CONSTRUCTION WITH EQUIVALENT MATERIALS AND CONSTRUCTION METHODS AS APPROVED BY THE FACILITY OWNER. ALL WORK TO REPAIR, MODIFY, REPLACE, OR ABANDON MONITORING WELLS/PIEZOMETERS WILL BE PERFORMED WITH THE APPROVAL OF THE OWNER, IN ACCORDANCE WITH APPLICABLE PUERTO RICO ENVIRONMENTAL QUALITY BOARD (PREQB) STANDARDS, AND BY A LICENSED WELL CONTRACTOR.
6. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH EXISTING PUERTO RICO DESIGN AND CONSTRUCTION STANDARDS UNLESS THOSE STANDARDS CONFLICT WITH THESE CONTRACT DOCUMENTS IN WHICH CASE THESE CONTRACT DOCUMENTS SHALL GOVERN. SUCH CONFLICTS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION IMMEDIATELY.
7. EXISTING WASTE SLOPES SHOWN ON SURVEY ARE SUBJECT TO CHANGE DUE TO SETTLEMENT OF WASTE, EROSION, AND REGRADING BY THE OWNER.
8. PRIOR TO BEGINNING EARTHWORK, THE CONTRACTOR SHALL PROVIDE STORMWATER AND EROSION CONTROL PLANS TO PREVENT PONDING AND CONTROL EROSION AND RUNOFF. THE CONTRACTOR SHALL MAINTAIN A CLEAR PATH FOR ALL SURFACE WATER DRAINAGE STRUCTURES AND DITCHES DURING ALL PHASES OF CONSTRUCTION. NO PONDING OF WATER ON WASTE SHALL BE ALLOWED. THE CONTRACTOR SHALL USE WHATEVER MEANS NECESSARY TO PREVENT EROSION AND TO MANAGE STORMWATER SUCH THAT IMPACT TO CONSTRUCTION IS MINIMIZED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK, INCLUDING PROVIDING EQUIPMENT, LABOR, FILL, ETC., NECESSARY TO REMEDIATE AND/OR RESTORE ALL AREAS IMPACTED BY EROSION AND STORMWATER.
9. THE CONTRACTOR SHALL PROVIDE ALL WARNING SIGNALS, SIGNS, LIGHTS, AND FLAG PERSON AS REQUIRED BY APPLICABLE PUERTO RICO STANDARDS.
10. STORMWATER CONTAMINATED BY CONTACT WITH SOLID WASTE OR DEWATERING DISCHARGE, SOLIDS CONTAMINATED BY THE CONTRACTOR, AND EXCAVATED WASTE SHALL BE CONTAINED AND PROPERLY DISPOSED OF AS REQUIRED BY PREQB.
11. CONTRACTOR SHALL PREVENT DISTURBANCE TO AND UNDERMINING OF ADJACENT STRUCTURES, SLABS, PIPING, AND OTHER UTILITIES/FACILITIES DURING CONSTRUCTION.
12. CONTRACTOR SHALL VERIFY ALL CLEARANCES AND PROPERTY BOUNDARIES PRIOR TO CONSTRUCTION AND SHALL PROVIDE WRITTEN NOTIFICATION TO THE ENGINEER PRIOR TO STARTING WORK, AS PART OF GENERAL NOTE 3, ABOVE.
13. NO DISTURBANCE SHALL BE ALLOWED OUTSIDE OF THE AREAS SHOWN ON THE FINAL GRADING PLAN UNLESS APPROVED BY THE ENGINEER, OR SPECIFICALLY NOTED ON THE PLANS.
14. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN ENVIRONMENTAL PROTECTION DURING THE LIFE OF THE CONTRACT, INCLUDING THE WARRANTY PERIOD. THE CONTRACTOR'S OPERATIONS SHALL COMPLY WITH ALL FEDERAL AND LOCAL REGULATIONS PERTAINING TO WATER, AIR, SOLID WASTE, HAZARDOUS WASTE TO COMPLY WITH THESE REGULATIONS FOR BOTH TEMPORARY AND PERMANENT CONSTRUCTION.
15. THE CONTRACTOR SHALL COMPLY WITH ALL TERMS, CONDITIONS, AND REQUIREMENTS OF ALL APPLICABLE PERMITS, INCLUDING THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA) AND PREQB PERMITS FOR THE SITE.
16. THE CONTRACTOR SHALL REPLACE ALL EXISTING PAVING, STABILIZED EARTH, FENCES, SIGNS, UTILITIES AND OTHER IMPROVEMENTS WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION, AS A RESULT OF CONSTRUCTION, OR AS DIRECTED BY THE ENGINEER WITHOUT INCREASE IN THE CONTRACT PRICE OR TIME.
17. CONTRACTOR SHALL SCHEDULE ALL WORK TO MAINTAIN AND ALLOW PROPER ACCESS FOR LANDFILL OPERATION VEHICLES AT ALL TIMES.

SITE HEALTH AND SAFETY

1. THIS PROJECT INVOLVES WORK AT AND AROUND A MUNICIPAL SOLID WASTE LANDFILL. THE CONTRACTOR SHALL PROTECT ALL PERSONNEL FROM ALL HAZARDS ASSOCIATED WITH WORKING AT A LANDFILL, INCLUDING CONTACT WITH LEACHATE AND OTHER CONTAMINATED MEDIA, LANDFILL GASES, MICROBIOLOGICAL AIRBORNE CONTAMINANTS, DANGEROUS CHEMICALS, SHARP OBJECTS, AND OTHER HAZARDOUS (CHEMICAL, PHYSICAL, AND RADIOLOGICAL, ETC.). AT A MINIMUM, THE CONTRACTOR SHALL COMPLY WITH THE BEST MANAGEMENT PRACTICES (MARCH 1992) AVAILABLE FROM THE SOLID WASTE ASSOCIATION OF NORTH AMERICA (SWANA). THE CONTRACTOR SHALL TAKE PRECAUTIONS NECESSARY TO ASSURE WORKER HEALTH AND SAFETY IN COMPLIANCE WITH OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) CHAPTERS 1910 AND 1926 (SPECIFICALLY WITH 1910.120), AND OTHER APPLICABLE REGULATIONS. A HEALTH AND SAFETY PLAN SHALL BE PREPARED.
2. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECESSARY TO PROTECT PERSONNEL FROM ASPHYXIA, POISONING, EXPLOSION, AND/OR OTHER HAZARDS DUE TO THE PRESENCE OF LANDFILL GASES, LEACHATE, WASTE, ETC.
3. CONTRACTOR SHALL PROVIDE AN INDEPENDENT HEALTH AND SAFETY SUPERVISOR ON-SITE DURING ALL PERIODS OF WASTE EXCAVATION AND TRENCHING.
4. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BECOME FAMILIAR WITH THE OSHA EXCAVATION SAFETY STANDARDS AND ABIDE BY THEM. CONTRACTOR SHALL CERTIFY IN WRITING TO THE ENGINEER, PRIOR TO STARTING WORK, THAT ALL WORK SHALL COMPLY WITH OSHA EXCAVATION SAFETY STANDARDS.

AS-BUILT SURVEY REQUIREMENTS

1. UPON COMPLETION OF CONSTRUCTION, THE CONTRACTOR SHALL PERFORM A FINAL TOPOGRAPHIC SURVEY TO PROVIDE THE REQUIRED RECORD DRAWING INFORMATION AND TO VERIFY THAT THE FINAL CONTOURS AND ELEVATIONS ARE IN ACCORDANCE WITH THE DRAWINGS AND CONTRACT DOCUMENTS.

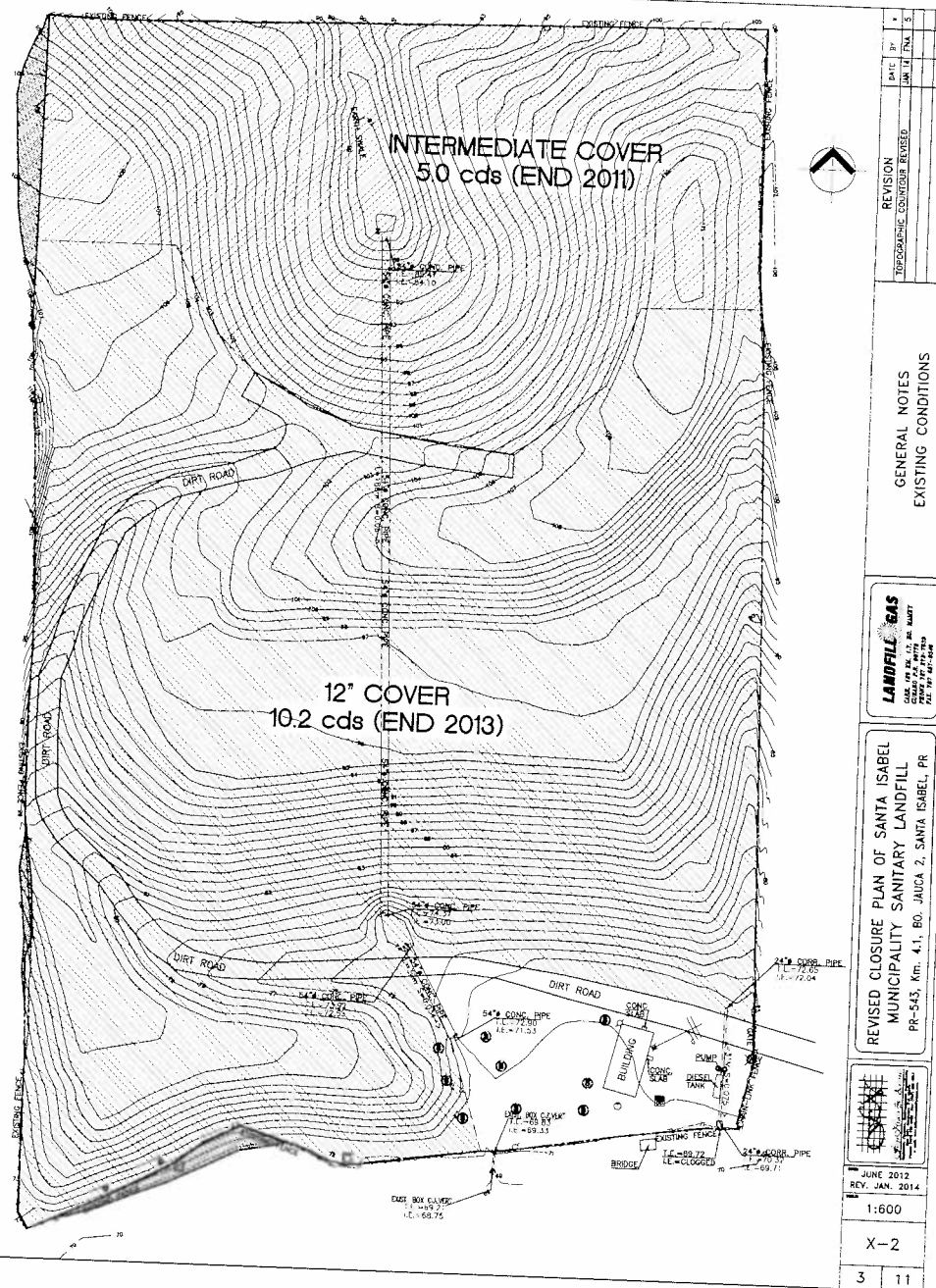
NOTES:

- 1) THE SURVEY WAS PERFORMED ON JAN 9, 2014 WITH A SOUTH NTS 362R TOTAL STATION AND A TRIMBLE RS GPS UNIT.
- 2) ALL DISTANCES ARE EXPRESSED IN METERS UNLESS OTHERWISE SPECIFIED.
- 3) HORIZONTAL CONTROL IS REFERRED TO PER LAMBERT NAD 83 REV. 2007 AND WAS ESTABLISHED WITH TRIMBLE RE-MODEL 2 DUAL FREQUENCY GPS UNITS.
- 4-IT WILL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY DIMENSIONS, ELEVATIONS AND ANY TOPOGRAPHIC DATA PRIOR TO CONSTRUCTION BEGINS. IN CASE OF DISCREPANCY OR DOUBT, THE CONTRACTOR SHALL REQUEST WRITTEN INFORMATION OF THE MATTER FROM THE ENGINEERS, WHO WILL HAVE FINAL DECISION ON WHAT SHALL BE CORRECTED, IF IT IS NECESSARY.
- 5-TOPOGRAPHIC DATA SHOWN ON THIS PLAN WAS OBTAINED FROM PLAN PREPARED BY LAND SURVEYOR EDGAR A. VELEZ GONZALEZ P.S., LIC. NO. 18051, TITLED "TOPOGRAFIA DE VEREDADERO DE SANTA ISABEL LUGO DE DEPÓSITO DE TOSCA Y PREVO A OBRAS CIVILES." THE DATA SHOWN WAS SURVEYED DURING JANUARY 9, 2014. SURVEYOR AND ENGINEERS ARE NOT RESPONSIBLE FOR ANY ALTERATION AFTER THIS DATE.
- 6-INTERMEDIATE COVER WAS PLACED IN THE NORTHERN SECTION OF THE LANDFILL AT THE END OF YEAR 2011. THE REMAINING AREAS IN THE LANDFILL HAVE BEEN COVERED APPROPRIATELY AT THE END OF YEAR 2013.
- 7-MUNICIPALITY SHALL BE RESPONSIBLE TO RELOCATE ALL MUNICIPAL SOLID WASTE LOCATED OUTSIDE OF ITS PROPERTY BOUNDARIES AND SHALL PREPARED THE AFFECTED AREAS TO SIMILAR PREVIOUS CONDITIONS.

LEGEND:

- PROPERTY LIMIT
- TOPOGRAPHIC CONTOUR
- ▲ HORIZONTAL & VERTICAL CONTROL
- FIRE HYDRANT
- PVC PIPE FILLED WITH CONCRETE
- SWD (STORM WATER DRAIN)
- PROTECTION PIPE
- WATER MONITORING WELL
- WATER METER
- WELL PIPE
- TREE
- GUY
- WOOD POLE
- WOOD POLE WITH LIGHT
- EXISTING FENCE TO BE REPAIRED IF REQUIRED
- ALUMINUM POLE & TRANSFORMER
- ALUMINUM POLE

OUTSIDE WASTE TO BE RELOCATED (SEE NOTE 7)

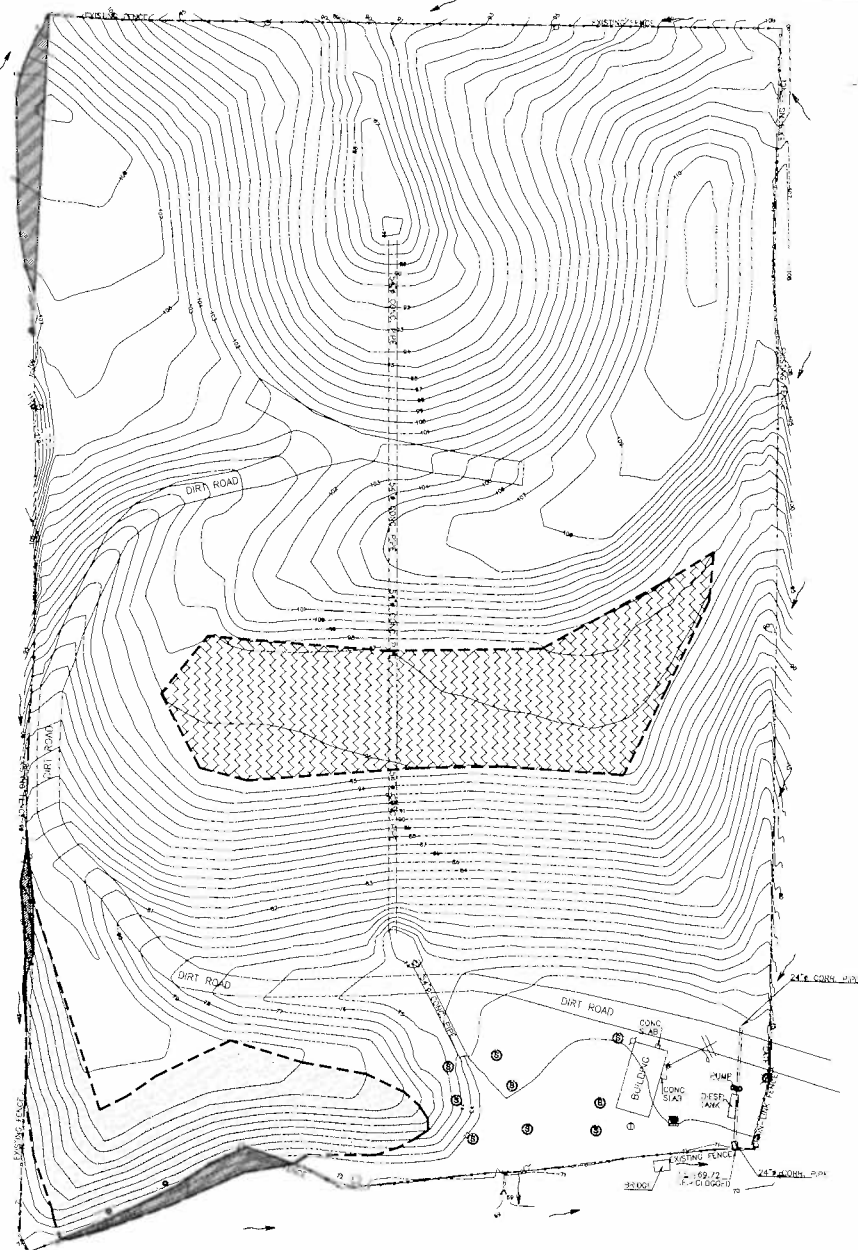


NOTES:

- 1-SEE NOTES ON PREVIOUS DRAWINGS.
- 2-SIDE SLOPES SHALL BE NO GREATER THAN 3:1 (H:V).
- 3-SEE CROSS SECTIONS ON DWG. NO. SI-4 TO SI-5.
- 4-MUNICIPALITY SHALL BE RESPONSIBLE TO RELOCATE ALL MUNICIPAL SOLID WASTE LOCATED OUTSIDE OF ITS PROPERTY BOUNDARIES AND SHALL PREPARE THE AFFECTED AREAS TO SIMILAR PREVIOUS CONDITIONS.
- 5-AREAS SHOWN AS TO BE REMOVED OR REGRADED, SHALL BE COVERED WITH A 12" INTERMEDIATE COVER.

LEGEND:

- PROPERTY LIMIT
- TOPOGRAPHIC CONTOUR
- ▲ HORIZONTAL & VERTICAL CONTROL
- ⊕ FIRE HYDRANT
- PVC PIPE FILLED WITH CONCRETE
- ⊙ SWD (STORM WATER DRAIN)
- PROTECTION PIPE
- ⊞ WATER MONITORING WELL
- ⊗ WATER METER
- ⊕ WELL PIPE
- ⊗ TRILL
- ↓ CUY
- ⊕ WOOD POLE
- ⊕ WOOD POLE WITH LIGHT
- ⊕ EXISTING FENCE TO BE REPAIRED IF REQUIRES
- ⊕ ALUMINUM POLE & TRANSFORMER
- ⊕ ALUMINUM POLE
- RUN-OFF DIRECTION
- ▨ OUTSIDE WASTE TO BE RELOCATED (SEE NOTE 4)
- ▨ AREA TO BE REMOVED AND REGRADED (SEE NOTE 5)
- ▨ RELOCATED WASTE AREA (SEE NOTES 4 & 5)



REVISION	DATE	BY	CHKD.	APP'D.
CHANGE WASTE COVER	10/12/12	PN	PN	PN
GENERAL REVISION	10/12/12	PN	PN	PN
COMPLIANCE OPERATION REVISION	10/12/12	PN	PN	PN

GENERAL SITE PLAN

LANDFILL GAS
 CONSULTING ENGINEERS
 1001 W. 10th St., Suite 100
 Anchorage, Alaska 99501
 Phone: (907) 562-1234
 Fax: (907) 562-1235

REVISED CLOSURE PLAN OF SANTA ISABEL
 MUNICIPALITY SANITARY LANDFILL
 PR-543, Km. 4.1, BO. LAICA 2, SANTA ISABEL PR

SEX
 ENGINEERING
 1001 W. 10th St., Suite 100
 Anchorage, Alaska 99501
 Phone: (907) 562-1234
 Fax: (907) 562-1235

JUNE 2012
 REV. JAN. 2014

1:600

SI-1

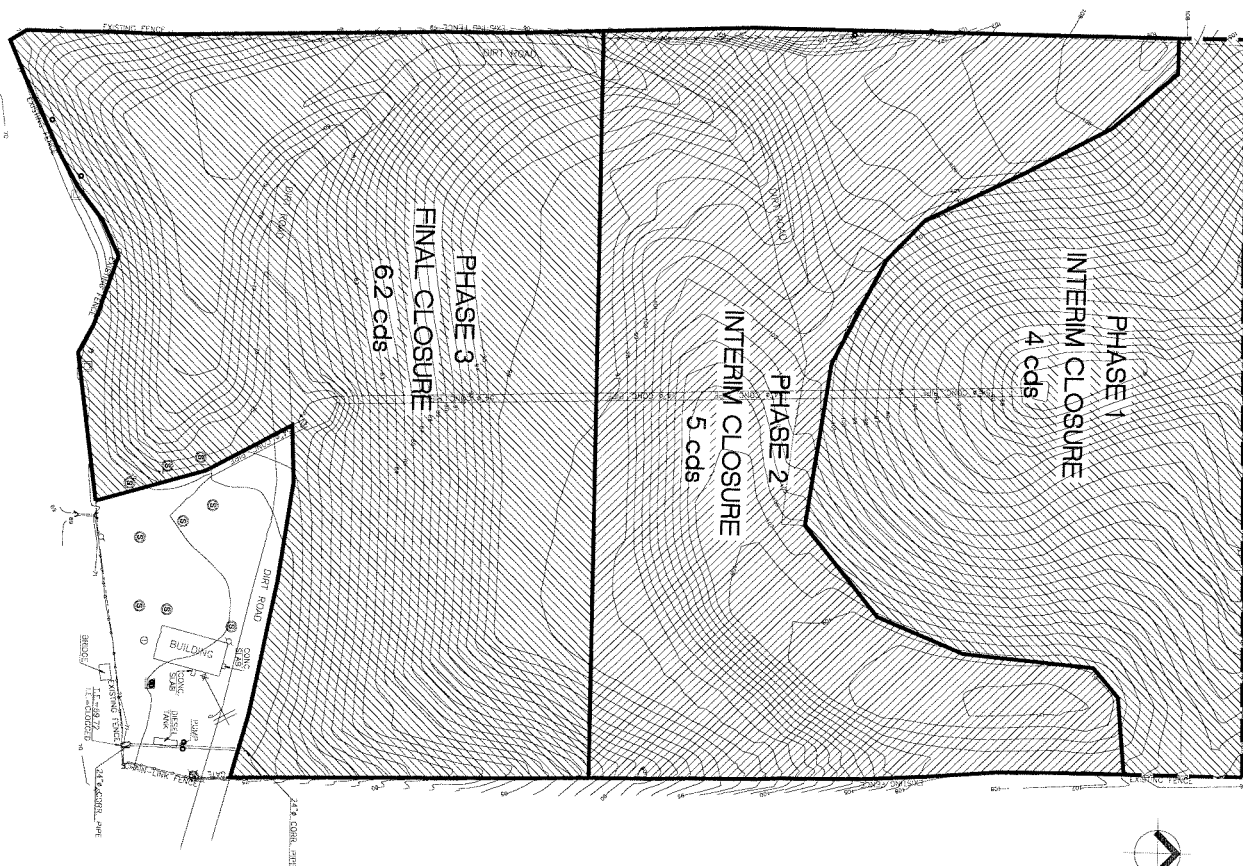
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NOTES:

1-SEE NOTES ON PREVIOUS DRAWINGS AND CLOSURE PLAN.

LEGEND:

- PROPERTY LIMIT
- TOPOGRAPHIC CONTOUR
- HORIZONTAL & VERTICAL CONTROL
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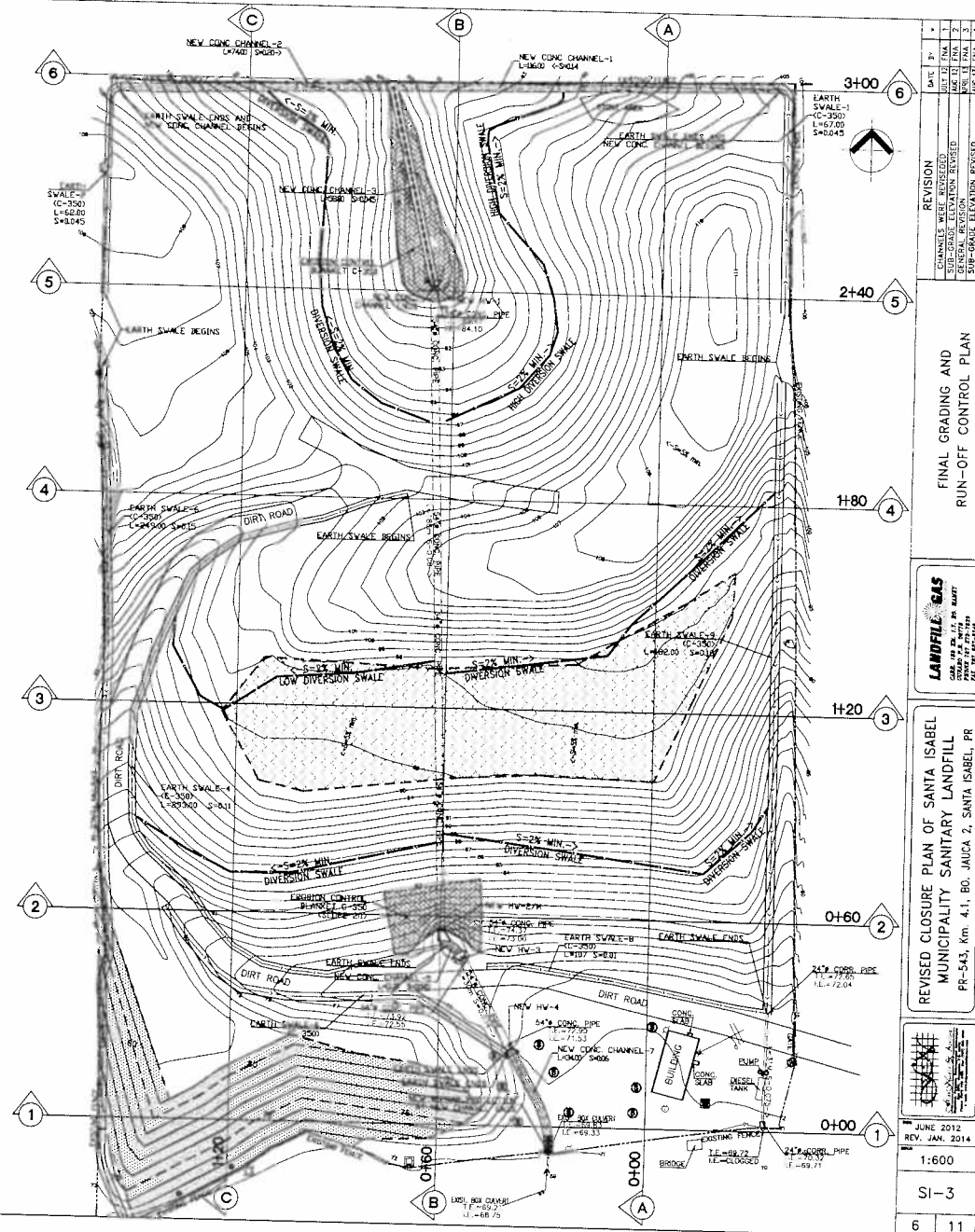


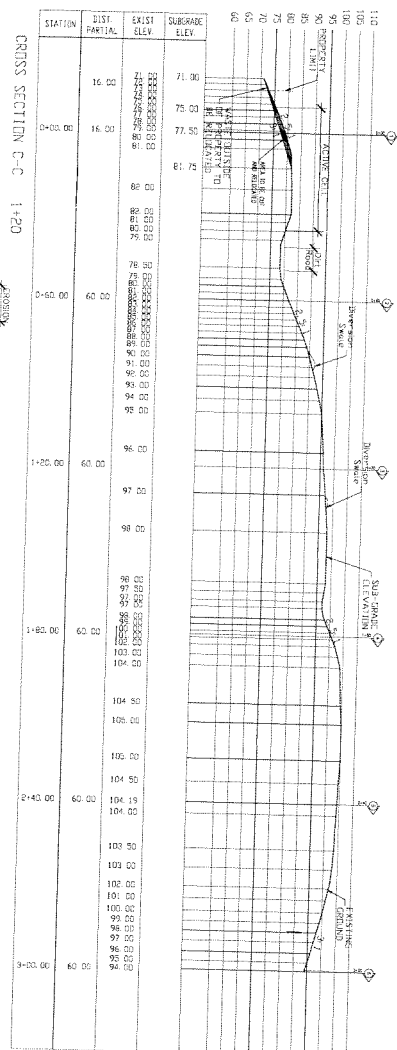
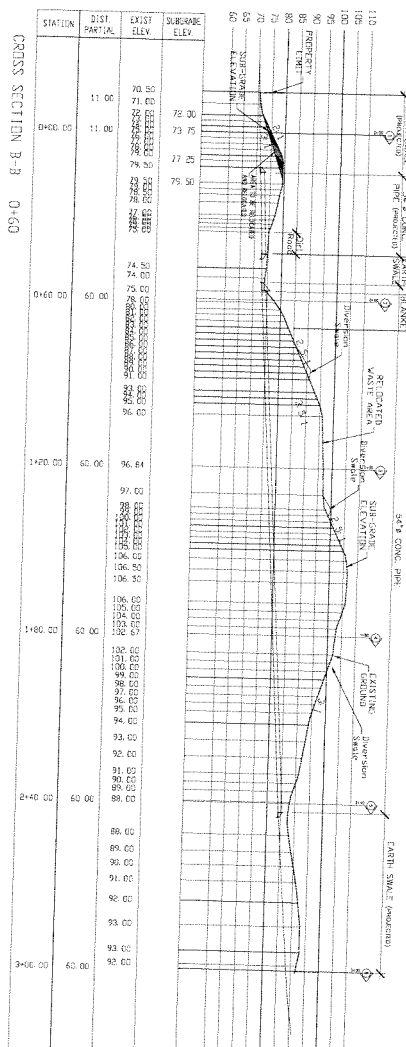
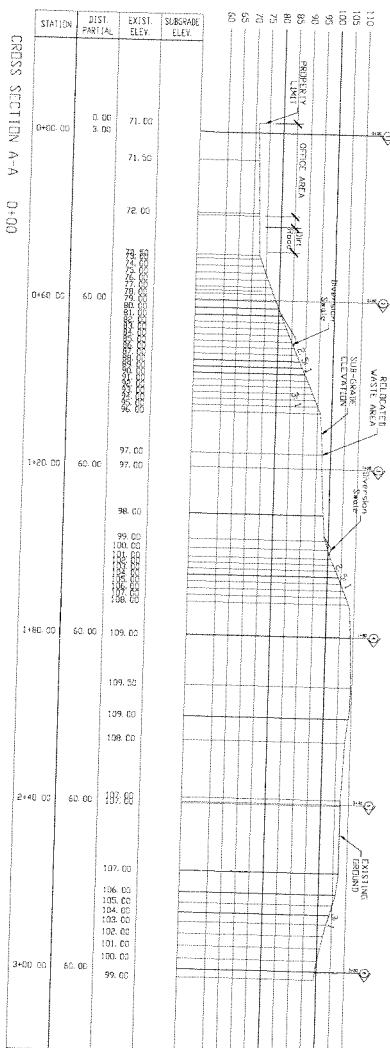
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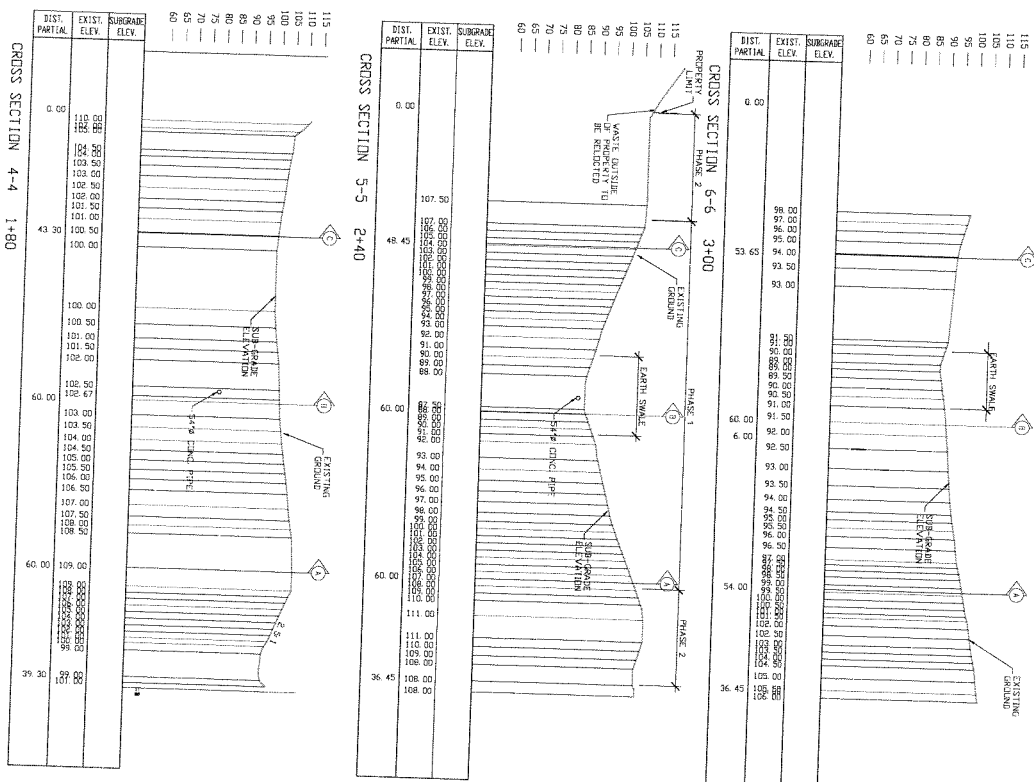
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LEGEND:

- PROPERTY LIMIT
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- ALUMINUM POLE & TRANSFORMER
- ALUMINUM POLE
- RUN-OFF DIRECTION
- REMOVED & REGRADED AREA (SEE NOTE 4)
- RELOCATED WASTE AREA (SEE NOTE 4)
- CONCRETE CHANNEL
- EARTH SWALE
- HEADWALL
- NEW TOPOGRAPHIC CONTOUR





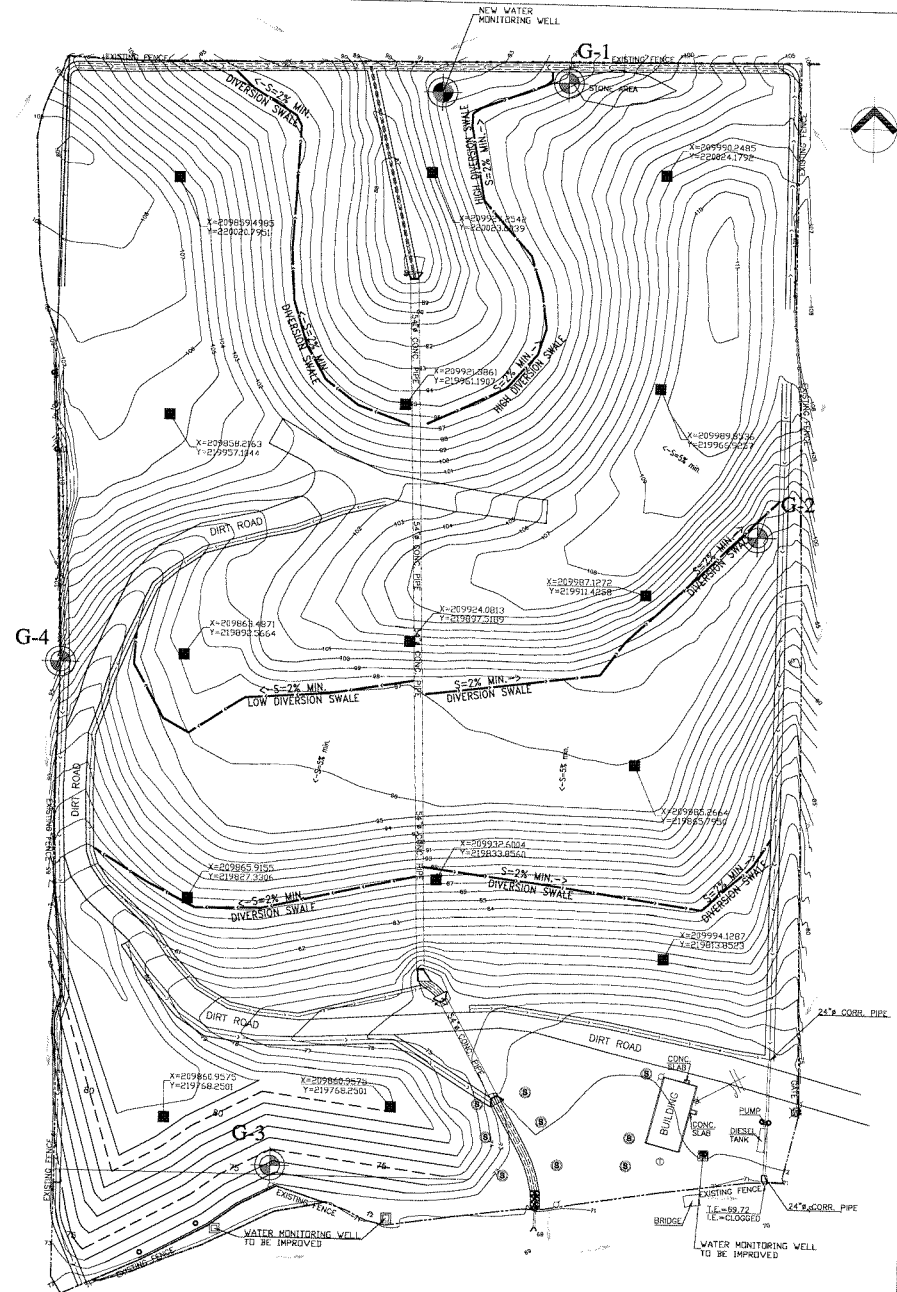


NOTES:

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- ⊕ ALUMINUM POLE & TRANSFORMER
- ⊕ ALUMINUM POLE
- RUN-OFF DIRECTION
- GAS VENT COLLECTION SYSTEM
- CONCRETE CHANNEL
- EARTH SWALE
- ⊕ HEADWALL
- NEW TOPOGRAPHIC CONTOUR
- ⊕ NEW WATER MONITORING WELL
- ⊕ GAS MONITORING WELL TO BE IMPROVED ACCORDING TO MONITORING PLAN



DATE	BY	REVISION
MAY 11	PA	1
MAY 11	PA	2
MAY 11	PA	3
MAY 11	PA	4

GAS COLLECTION AND MONITORING PLAN
GROUND WATER MONITORING LAYOUT

LANDFILL GAS
GAS 102 PM 12.24.04
GAS 102 PM 12.24.04
GAS 102 PM 12.24.04
GAS 102 PM 12.24.04

REVISED CLOSURE PLAN OF SANTA ISABEL
MUNICIPALITY SANITARY LANDFILL
PR-543, Km. 4.1, BO. JAUCA 2, SANTA ISABEL, PR

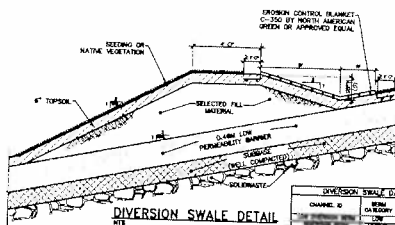


JUNE 2012
REV. JAN. 2014

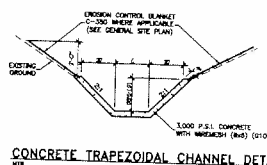
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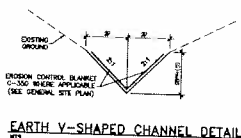
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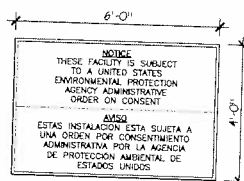
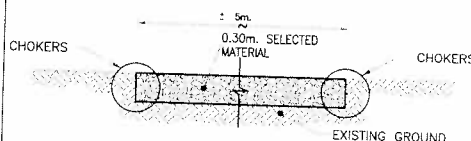
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1.0	1.0	1.0
1.0	1.0	1.0



CHANNEL D	CHANNEL B	CHANNEL A
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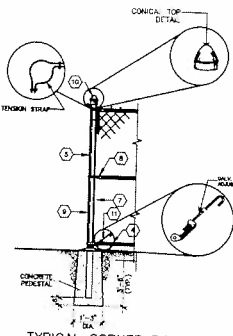
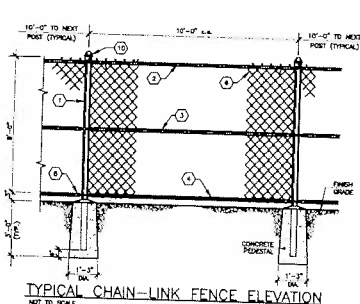
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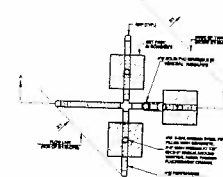
NOTICE SIGN DETAIL

LIST OF MATERIAL FOR CHAIN-LINK FENCE

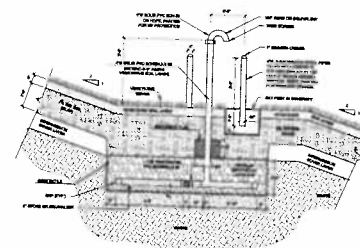
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- 2- TOP RAIL 1 1/2" DIA. 3.00 GALV.
- 3- MIDDLE RAIL 1 1/2" DIA. 3.00 GALV.
- 4- BOTTOM RAIL 1 1/2" DIA. 3.00 GALV.
- 5- CORNER POST 1 1/2" DIA. 3.00 GALV.
- 6- TENSION BAR 1 1/2" DIA. 3.00 GALV.
- 7- RAIL END CAP 1 1/2" DIA.
- 8- BRACE BAND - SIZE AS REQUIRED
- 9- POST CAP
- 10- GALV. POST BAR W/ANCHOR TURN RIGIDLY



TYPICAL CORNER POST DETAIL



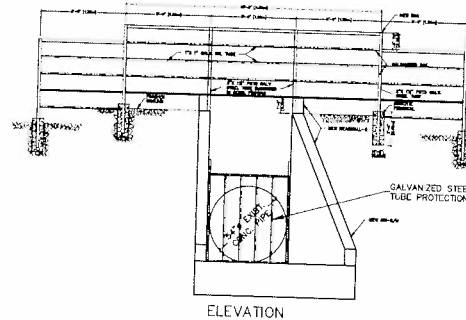
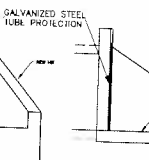
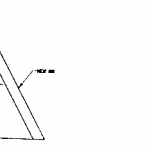
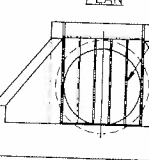
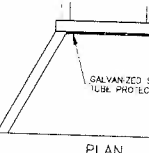
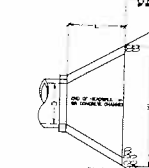
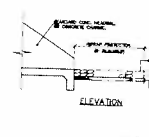
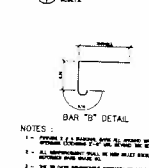
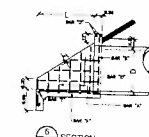
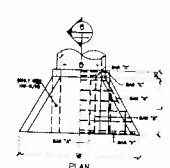
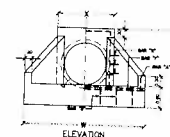
TYPICAL GAS VENT ON TERRACE



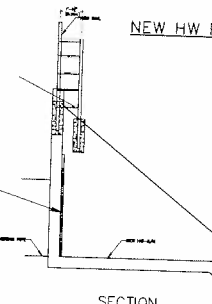
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CONCRETE HEADWALL DETAILS

NOT TO SCALE



NEW HW-2/M RAIL AND PROTECTION DETAIL



NEW HW PROTECTION DETAIL

TABLE OF DIMENSIONS FOR STANDARD HEADWALLS
1.0
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1.0
1.0
1.0

DATE	BY	REVISION
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1.0	1.0	1.0
1.0	1.0	1.0
1.0	1.0	1.0

CLOSURE DETAILS

LANDFILL GAS

REVISED CLOSURE PLAN OF SANTA ISABEL MUNICIPALITY SANITARY LANDFILL

PR-543, Km. 4.1, BO. JAICA 2, SANTA ISABEL, PR

JUNE 2012

REV. JAN. 2014

AS SHOWN

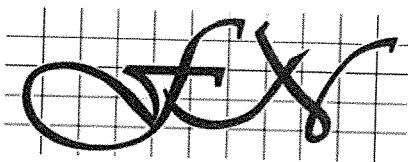
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Appendix C

Stormwater Management System Design Calculations



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Santa Isabel Landfill
PEAK DISCHARGE RATE CALCULATION

C1.1 OVERVIEW

Estimate the peak discharge for different drainage basins resulting from a 24-hr 25-yr rainfall event. The peak discharge was estimated using the methodology outlined in TR 55 (USDA, 1986).

C1.2 PEAK DISCHARGE

Peak discharge was calculated using the following equation.

$$q_p = q_u \times A_m \times Q_r \times F_p$$

Where,

q_p = peak discharge (cfs)

q_u = unit peak discharge (csm/in)

A_m = drainage area (mi²)

Q_r = runoff (in)

F_p = pond and swamp adjustment factor (=1.00 for 0% pond and swamp area)

C1.3 ESTIMATION OF Q_r

Q_r was estimated using the following equation.

$$Q_r = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Where,

P = 24-hr 25-yr rainfall [=11.2 in. based on IDF curve information for Santa Isabel, Puerto Rico (NOAA, 2014)]

Potential maximum retention after runoff, $S = \frac{1000}{CN} - 10 = 2.50$

Where, CN is the curve number that depends on the soil hydrologic group and cover.

Santa Isabel Landfill

PEAK DISCHARGE RATE CALCULATION

-Clay (soil hydrologic group D, Appendix A, TR-55) with over 75% grass cover was assumed. Using Table 2.2a in TR55, CN was estimated to be 80.

$$\text{Estimated runoff, } Q_r = \frac{(P - 0.2S)^2}{(P + 0.8S)} = 8.67 \text{ in}$$

-Constancia (soil hydrologic group D, Appendix A, TR-55) with over desert shrub was assumed. Using Table 2.2a in TR55, CN was estimated to be 88.

$$\text{Estimated runoff, } Q_r = \frac{(P - 0.2S)^2}{(P + 0.8S)} = 9.72 \text{ in}$$

C1.4 ESTIMATION OF q_u

The unit peak discharge depends on the time of concentration (T_c) which in turn depends on drainage length (L) and the slope (S). The time of concentration (T_c), is directly proportional to the drainage length and inversely proportional to the slope. In the event drainage length was greater than 300 ft, sheet flow was assumed for the first 300 ft, and flow beyond 300 ft was assumed to occur in shallow concentrated channels. As can be seen in the drawings presented in Figure C1-3, drainage areas A3 and A4 have the mildest slope and greatest drainage length. The slope of the other drainage basins are, for the most part, 33.3% (3:1 (H:V)); drainage area A4 has the largest area out of all the basins with a slope of 3:1 (H:V). The unit peak discharge (q_u) was estimated for drainage areas A3 and A4.

The travel time (T_{t1}) for sheet flow was calculated using the following equation:

$$T_{t1} = \frac{0.007 \times (n \times L_1)^{0.8}}{P_2^{0.5} \times S_1^{0.4}}$$

Where,

n = Manning's roughness coefficient (Table 3-1, TR-55)

L_1 = Flow length with assumed sheet flow (ft)

P_2 = 2-yr 24-hr rainfall (in) (= 4.76 in based on IDF curve information for the Santa Isabel, Puerto Rico (NOAA, 2014))

S_1 = slope of the drainage length (ft/ft)

Santa Isabel Landfill

PEAK DISCHARGE RATE CALCULATION

The travel time for shallow concentrated channel flow was calculated using the following equation:

$$T_{t2} = \frac{L_2}{3600v}$$

Where,

L_2 = Flow length (ft)

v = average flow velocity (ft/s) (estimated using Figure 3-1 of TR-55 for unpaved case)

Table C1-1 presents the inputs used for estimating the time of concentration for estimation for Areas 3 and 4.

Table C1-1. Inputs used for estimating the time of concentration for Areas A3 and A4

	Drainage Area A3	Drainage Area A4	Units
Drainage Length, L (From the hydrologically most distant point from the bench)	197	1394	ft
Drainage Length (sheet flow), L_1	197	1148	ft
Drainage Length, L_2	-	246	ft
Slope, s_1	0.33	0.33	ft/ft
Slope, s_2	-	0.67	ft/ft
Manning's Roughness Coefficient (n)	0.24	0.24	
P_2	4.76	4.76	in
Velocity (V) for shallow conc. flow regime	10	10	ft/s
T_{t1}	0.11	0.45	hr
T_{t2}	-	0.10	hr
Time of concentration (T_c)	0.11	0.55	hr

Santa Isabel Landfill
PEAK DISCHARGE RATE CALCULATION

The unit peak discharge (q_u) depends on the ratio of initial abstraction ($I_a = 0.2s$) and precipitation (P). The ratio was calculated to be 0.054. The unit peak discharge (q_u) was estimated using exhibit 4-II in TR-55 (reproduced below).

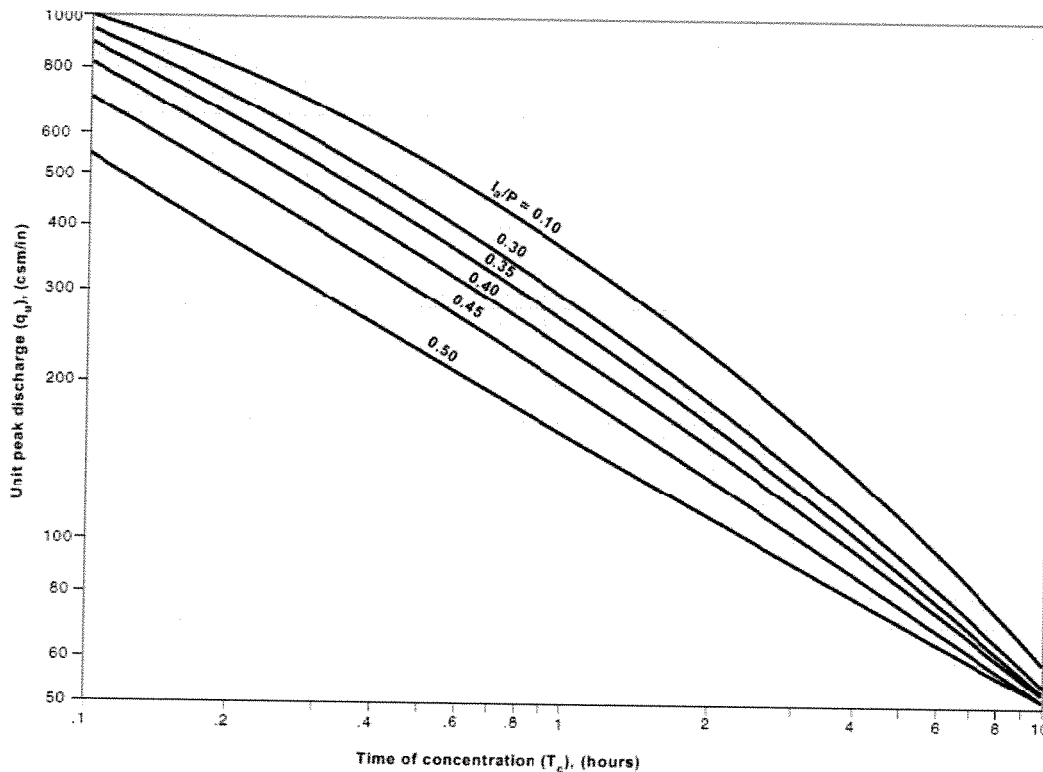


Figure C1-1 Unit peak discharge (q_u) for NRCS (SCS) Type II rainfall distribution.

A q_u of 1,000 was used for estimating peak discharge for all areas and channel except for Areas A1, A4, A5, A9 & A17 for a more conservative design. A q_u of 600 was used for estimation of peak discharge rate from Areas A1, A4, A5, A9 & A17. Table C1-2 presents contributing areas, unit peak discharge rate and peak discharge rate for the proposed areas. Table C1-3 presents contributing areas and peak discharge rate for the proposed channels. Refer to the drawings in Figures C1-2 y C1-3 for areas delineations.

Santa Isabel Landfill
PEAK DISCHARGE RATE CALCULATION

Table C1-2. Peak discharge for the proposed areas.

Area	Meter ²	Acres	Miles ²	Unit Peak q _u	Peak Disch q _p (cfs)	Peak Disch q _p (cms)
A1	52,747.14	13.03	0.0204	600	118.76	3.37
A2	2,243.47	0.55	0.0009	1,000	7.51	0.21
A3	6,392.77	1.58	0.0025	1,000	21.41	0.61
A4	119,419.71	29.51	0.0461	600	268.87	7.62
A5	36,323.51	8.98	0.0140	600	81.78	2.32
A6	1,796.46	0.44	0.0007	1,000	6.02	0.17
A7	2,776.00	0.69	0.0011	1,000	9.30	0.26
A8	5,431.96	1.34	0.0021	1,000	18.19	0.52
A9	23,274.24	5.75	0.0090	600	52.40	1.48
A10	1,602.76	0.40	0.0006	1,000	5.37	0.15
A11	3,604.25	0.89	0.0014	1,000	12.07	0.34
A12	4,131.72	1.02	0.0016	1,000	13.84	0.39
A13	4,090.04	1.01	0.0016	1,000	13.70	0.39
A14	1,290.34	0.32	0.0005	1,000	4.32	0.12
A15	541.06	0.13	0.0002	1,000	1.81	0.05
A16	2,903.08	0.72	0.0011	1,000	9.72	0.28
A17	23,363.37	5.77	0.0090	600	52.60	1.49
A18	3,134.35	0.77	0.0012	1,000	10.49	0.30
A19	2,644.23	0.65	0.0010	1,000	8.85	0.25
A20	1,624.90	0.40	0.0006	1,000	5.44	0.15
A21	1,421.43	0.35	0.0005	1,000	4.76	0.13
A22	2,956.10	0.73	0.0011	1,000	9.90	0.28
A23	3,779.53	0.93	0.0015	1,000	12.65	0.36
A24	5,392.13	1.33	0.0021	1,000	18.05	0.51
A25	3,848.61	0.95	0.0015	1,000	12.88	0.37
Total	316,733.17	78.27	0.1223			

Santa Isabel Landfill

PEAK DISCHARGE RATE CALCULATION

Table C1-3. Peak discharge for proposed channels

Area	Meter ²	Acres	Miles ²	Unit Peak q_u	Peak Disch q_p (cfs)	Peak Disch q_p (cms)
1	61,383.38	15.17	0.0237	A1, A2, A3	147.68	4.19
2	40,895.97	10.11	0.0158	A5, A6, A7	97.09	2.75
3	227,131.03	56.13	0.0877	1, 2, A4, A8	531.83	15.07
4	12,426.19	3.07	0.0048	A19 - A23	41.60	1.18
5	239,557.22	59.20	0.0925	3, 5	573.42	16.25
6	31,889.86	7.88	0.0123	A17, A18, A24	81.14	2.30
7	271,447.08	67.08	0.1048	6, 7	654.57	18.55
8	4631.10	1.14	0.0018	A13, A15	15.51	0.44
9	33,903.30	8.38	0.0131	A9 - A12, A14	88.00	2.49

C1.5 REFERENCES

NOAA (2014). Hydrometeorological Design Studies Center: Precipitation Frequency Data. Server. US Department of Commerce
<<http://dipper.nws.noaa.gov/hdsc/pfds/>>.

USDA (1986). Urban Hydrology for Small WatershedsTR-55. Natural Resources Conservation Service. Conservation Engineering Division

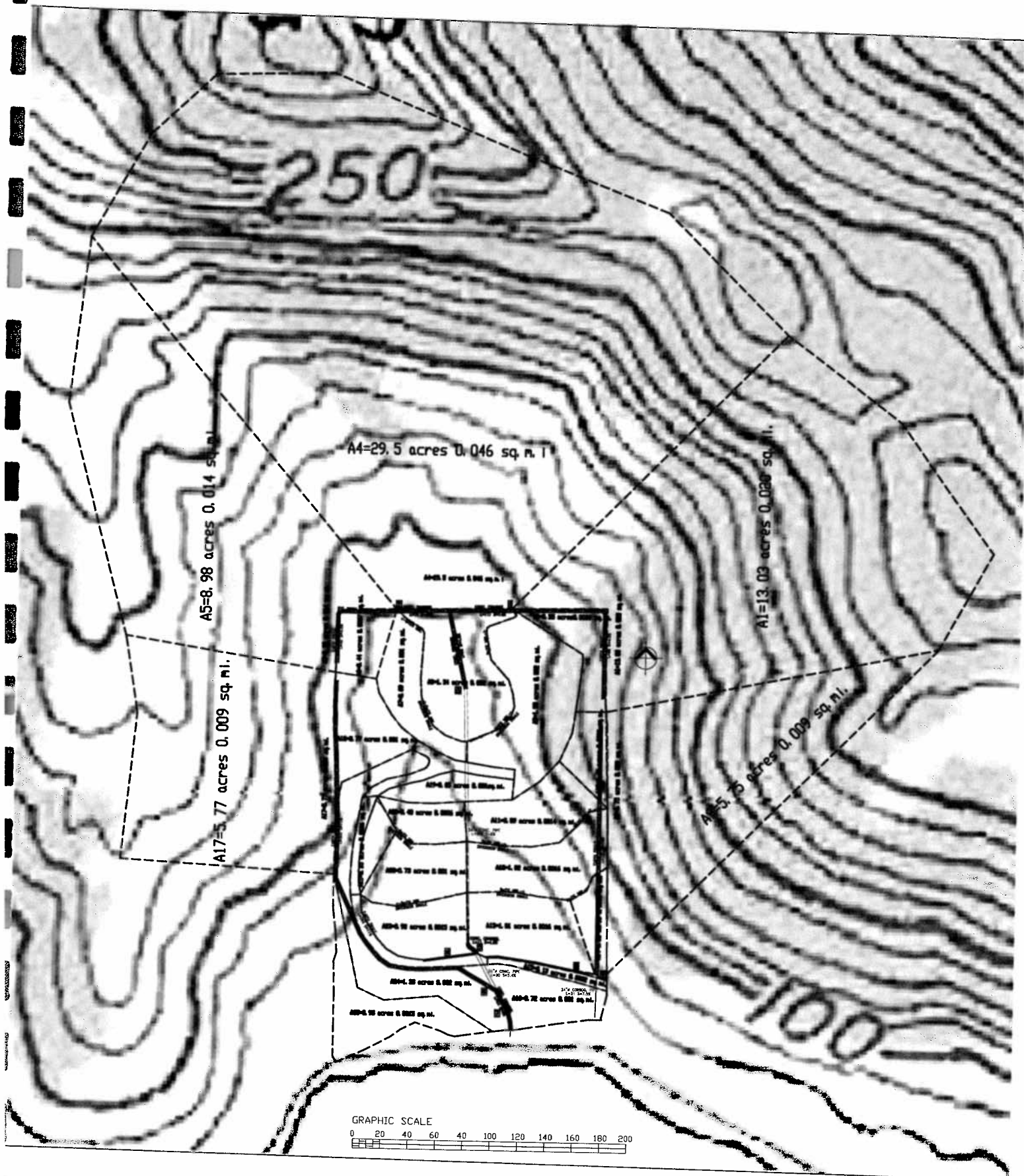
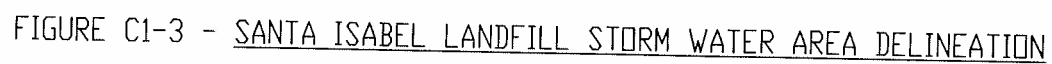
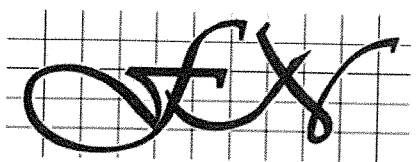


FIGURE C1-2 - SANTA ISABEL LANDFILL STORM WATER OFF-SITE DELINEATION





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Santa Isabel Landfill
DIVERSION BERM SIZING CALCULATIONS

C2.1 OVERVIEW

The berms were sized to handle the estimated peak flow rates presented in Appendix C1. Manning's equation was used to estimate the berm size required to handle the design flow rate.

C2.2 DESIGN FLOW RATE

Table C2-1 presents the distribution of the peak runoff rate for all the proposed berms. It can be seen that the peak flow rate for one (1) of the proposed berms is estimated to be less than 0.20 m³/s, four (4) of the proposed berms are estimated to be more than 0.20 m³/s and only one (1) berm out of the six (6) total proposed would have peak flow rates greater than 0.60 m³/s.

Table C2-1. Diversion berm peak discharge distribution

Berm Catchment Area	Peak Discharge Rate, Q (ft ³ /s)	Peak Discharge Rate, Q (m ³ /s)
A3	21.41	0.61
A7	9.30	0.26
A11	12.07	0.34
A12	13.84	0.39
A20	5.44	0.15
A22	9.90	0.28

To optimize earthwork associated with the construction of these berms, berms were classified into three categories as listed in Table C2-2.

Santa Isabel Landfill
DIVERSION BERM SIZING CALCULATIONS

Table C2-2 Proposed berm categories and peak flow rates

Berm Category	Peak Flow rate (m ³ /s)
Low Capacity	$Q \leq 0.20$
Medium Capacity	$0.20 < Q \leq 0.60$
High Capacity	$Q > 0.60$

C2.3 BERM SIZING CALCULATIONS

V-shapes berms as shown in Figure C2-1 are proposed. The side that interfaces with the landfill will be sloped at 3:1 (H:V) (33%). The other side will be sloped at 2:1 (H:V) (50%). The berms will be lined with native grass to minimize erosion at a minimum and will be sloped longitudinally at 2% (minimum).

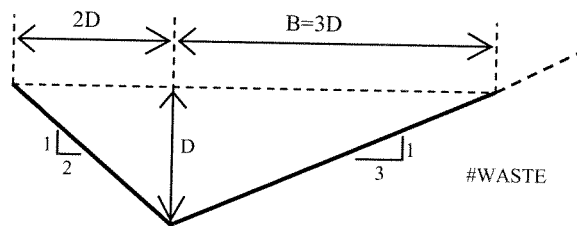


Figure C2-1. Schematic of the proposed diversion berm

The flow rates of the berms were calculated using the flow equation.

$$Q = AV$$

Where,

$$A = \text{Area of the flow} = \frac{1}{2} \times D \times (2D+3D) = 2.5 D^2$$

$$\text{And } V = \frac{1}{n} (R_H)^{2/3} s^{1/2}$$

Where,

V = average flow velocity (m/s)

s = slope = 2% (minimum)

n = Manning's roughness coefficient = 0.025 for natural channel in good condition
(Linsley and Franzini, 1964)

R_H = Hydraulic radius = A / W

Santa Isabel Landfill

DIVERSION BERM SIZING CALCULATIONS

$$W = \text{wetted perimeter} = \sqrt{D^2 + (2D)^2} + \sqrt{D^2 + (2D)^2} \\ = (\sqrt{5} + \sqrt{10})D = 5.40D$$

$$R_H = 2.5D^2 / 5.40D = 0.463D$$

$$V = \frac{1}{n} (0.463D)^{2/3} s^{1/2} = 3.385D^{2/3}$$

$$Q = 2.5D^2 \times 3.385D^{2/3} = 8.46D^{8/3} \text{ m}^3/\text{s}$$

Another consideration that should be assessed when designing stormwater berms is erosion potential. Velocity and tractive stresses are the two criteria that are used to characterize the erosion potential of channels. Native grass lining is proposed for diversion berms. Fischenich (2001) reported that the tractive stresses for a native grass-lined channel should be less than 0.06 kN/m² to 0.08 kN/m² (1.2 lb/ft² to 1.7 lb/ft²) to limit erosion. Similarly, the flow velocity in a grass-lined channel should be less than 1.2 to 1.83 m/s to limit erosion. Tractive stresses were calculated using the following equation for the maximum stormwater flow rate achieved in the diversion berm:

$$\tau = \gamma_w \times D \times S$$

Where,

τ = tractive stresses, kN/m²

γ_w = unit weight of water, 9.807 kN/m³

D = depth of flow, m

S = longitudinal slope (2%)

Table C2-3 presents the proposed dimensions and flow rate carrying for the proposed berms along with the maximum tractive stress. The maximum tractive stress (τ_{\max}) and fluid velocity (V_{\max}) were calculated to be within the ranges reported by Fischenich (2001). Therefore, native grass lining was found to be appropriate for the proposed berms.

Santa Isabel Landfill
DIVERSION BERM SIZING CALCULATIONS

Table C2-3. Dimensions, flow rates, and tractive stresses for the proposed berms

Berm Catchment Area	Depth D		Width B = 3D		Q (m ³ /s) (8.46D ^{8/3})	V _{max} (m/s)	τ _{max} (kN/m ²)
	m	inches	m	inches			
Low Capacity	0.25	10"	0.75	30"	0.15	1.4	0.049
Medium Capacity	0.30	12"	0.90	36"	0.32	1.6	0.059
High Capacity	0.40	16"	1.20	48"	0.61	1.8	0.076

C2.4 REFERENCES

Fischenich, C. (2001). Stability Thresholds for Stream restoration Materials. EMRRP Technical Notes Collection: ERDS TN-EMRRP-SR-29. US Army Corp of Engineers Research and Development Center.

Linsley, R.K. and J. B. Franzini (1964). Water Resources Engineering. McGraw-Hill, New York.



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Santa Isabel Landfill
CONCRETE CHANNEL SIZING CALCULATIONS

C3.1 OVERVIEW

The objective of the calculations presented in this section is to design the concrete channel size needed for the designed stormwater conveyance system. The stormwater trapezoidal channels will be constructed at the northern periphery, upstream of the existing 54" Ø RCP's and downstream of existing concrete pipe in the south of the facility. Otherwise, the V-shaped channels will be constructed at the peripheries in the east and the west, and along the right side of the existing access road.

C3.2 DESIGN FLOW RATE

Table C3-1 presents the flow rates the proposed channels will be designed to handle. Refer to Appendix C1 (Table C1-3) for details on the flow rate estimations and drawings in Figure C1-3 for channel locations.

Table C3-1. Design Flow Rates for Channels

Channel ID	Peak Discharge Rate (ft ³ s)	Peak Discharge Rate (m ³ s)
1 *	147.68	4.19
2 *	97.09	2.75
3 *	531.83	15.07
4	41.60	1.18
5 *	573.42	16.25
6	81.14	2.30
7 *	654.57	18.55
8	15.51	0.44
9	88.00	2.49

* Trapezoidal Channel. V channels are identified without the asterisk (*).

Santa Isabel Landfill
CONCRETE CHANNEL SIZING CALCULATIONS

C3.3 CHANNEL SIZING CALCULATIONS

Trapezoidal-shaped channels as shown in Figure C3-1 are proposed. The sides will be sloped at 2:1 (H:V) (50%). The channels will be made in reinforced concrete to avoid erosion.

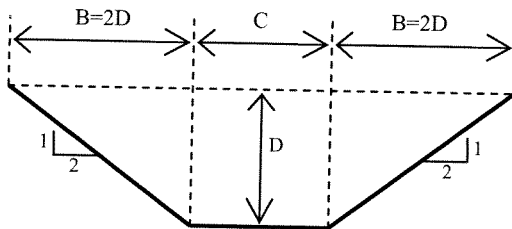


Figure C3-1. Schematic of the proposed trapezoidal channels

The flow rates of the channels were calculated using the flow equation.

$$Q = AV$$

Where,

$$A = \text{Area of the flow} = \frac{4D + C + C}{2} (D) = 2D^2 + CD$$

$$\text{And } V = \frac{1}{n} (R_H)^{2/3} s^{1/2}$$

Where,

V = average flow velocity (m/s)

s = slope

n = Manning's roughness coefficient = 0.013

R_H = Hydraulic radius = A / W

$$\begin{aligned} W = \text{wetted perimeter} &= \sqrt{(2D)^2 + D^2} \times 2 + C \\ &= \sqrt{5D^2} \times 2 + C \end{aligned}$$

$$R_H = \frac{2D^2 + CD}{\sqrt{5D^2} \times 2 + C} = \frac{2D^2 + CD}{4.47D + C}$$

$$V = \frac{1}{n} \left(\frac{2D^2 + CD}{4.47D + C} \right)^{2/3} s^{1/2}$$

$$Q = (2D^2 + CD) \times \frac{1}{n} \left(\frac{2D^2 + CD}{4.47D + C} \right)^{2/3} s^{1/2}$$

Santa Isabel Landfill
CONCRETE CHANNEL SIZING CALCULATIONS

Table C3-2 presents the parameters to be used in the Manning's formula for different concrete channels with variable bottom widths and taking in consideration existing slopes. See hydraulic outputs (velocities, discharges and others) in section C3.3 for the trapezoidal channels in concrete that were evaluated, some of them are presented in the following table.

Table C3-2. Dimensions, flow rates and other parameters for the proposed concrete channels

Concrete Channel bottom width (C) (ft)	Concrete Channel depth (D) (ft)	Slopes (ft/ft)	Velocity (ft/sec)	Flow Depth capacity (m ³ /sec)	Flow Depth capacity (ft ³ /sec)
1'-0"	1'-0"	0.045	16.24	1.38	48.73
		0.060	18.75	1.59	56.26
		0.100	24.21	2.06	72.64
2'-0"	2'-0"	0.045	25.78	8.76	309.39
		0.060	29.77	10.12	357.25
		0.100	38.43	13.06	461.21
2'-0"	3'-0"	0.045	32.57	22.14	781.67
		0.060	37.67	25.56	902.59
2'-6"	2'-6"	0.045	29.92	15.89	560.96
		0.060	34.55	18.34	647.74

C3.3 HYDRAULIC OUTPUTS FOR THE TRAPEZOIDAL ONCRETE CHANNELS

On the following pages are presented the hydraulic outputs for all evaluated channels in concrete with a trapezoidal shape. The outputs were obtained using Flow Master v5.07 of Haestad Methods, Inc.